BEFORE THE

FEDERAL ENERGY REGULATORY COMMISSION

APPLICATION FOR LICENSE
MAJOR PROJECT — EXISTING DAM

BROADWATER POWER PROJECT

Project No. 2853

MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION
HELENA, MONTANA

MAY 1982

BEFORE THE

FEDERAL ENERGY REGULATORY COMMISSION

APPLICATION FOR LICENSE FOR BROADWATER POWER PROJECT

PROJECT NO. 2853

MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION

HELENA, MONTANA

MAY 1982

Prepared in association with:

TUDOR ENGINEERING COMPANY

San Francisco, California

BEFORE THE
FEDERAL ENERGY REGULATORY COMMISSION

Broadwater Power Project — Project No. 2853

APPLICATION FOR LICENSE
FOR
MAJOR PROJECT-EXISTING DAM
BY
MONTANA DEPARTMENT OF NATURAL
RESOURCES AND CONSERVATION

---

1. The Montana Department of Natural Resources and Conservation (hereinafter referred to as the "Applicant") applies to the Federal Energy Regulatory Commission for a license for the Broadwater Power Project, as described in the attached exhibits.

2. The location of the project is:

State:	Montana
County:	Broadwater
Township or Nearby Town:	The site of the power plant is approximately four miles south of Toston, Montana, and is in the NW 1/4 of Section 7, Township 4 North, Range 3 East of the Principal Meridian, Montana.
Stream:	Missouri River

3. The exact name and address of the Applicant are:

Montana Department of Natural
Resources and Conservation
32 South Ewing
Helena, Montana 59601
(406) 449-2864

The exact name and business address of the person authorized to act as agent for Applicant in this application is:

Richard L. Bondy
Montana Department of Natural
Resources and Conservation
32 South Ewing
Helena, Montana 59601

4. The Applicant is a state acting pursuant to Title 85, Part 5 of the Montana Code Annotated, which grants authority to the Department of Natural Resources and Conservation to lease state-owned sites for hydroelectric power projects or to develop the sites and sell the power to utilities, electric cooperatives, or federal power marketing agencies.

5. The Applicant has filed water right application No. 16825, as amended, with the Montana Water Rights Bureau for non-consumptive water use of 7,200 cfs up to 5,216,000 acre-feet per year to operate the Broadwater Power Project. This represents the maximum capacity of the four turbines planned for the site. The Applicant will comply with the laws of the State of Montana with respect to obtaining property rights and with state laws including but not limited to the Montana Environmental Policy Act, the Natural Streambed and Land Preservation Act, Water Quality Act, and Air Quality Act. The Applicant is authorized to engage in the business of producing and transmitting power and any other business necessary to accomplish the purposes of the requested license.

6. Broadwater Dam is owned by the Applicant.

7. The following exhibits are filed herewith and are hereby made a part of this application for license:

Exhibit A - Project Description
Exhibit B - Project Operation and Resource Utilization
Exhibit C - Construction History and Schedule
Exhibit D - Costs and Financing
Exhibit E - Environmental Report
Exhibit F - General Design Drawings and Supporting Design Report
Exhibit G - Project Maps

All of the above listed exhibits, except Exhibit F, General Design Drawings and Supporting Design Report, and Exhibit G, are attached to this application. Exhibit G and part of Exhibit F are drawings that will be submitted under separate cover upon the acceptance of this application. A photographic reduction of each drawing is included herein. The Supporting Design Report for Exhibit F is included as a separate volume of this license application.

IN WITNESS HEREOF, the Applicant has caused its name to be hereunto signed by its Director this 20th day of May, 1982.

MONTANA DEPARTMENT OF NATURAL
RESOURCES AND CONSERVATION

By ______________________

VERIFICATION

State of Montana)
) ss
County of Broadwater)

Mr. Leo Berry, being duly sworn, deposes and says:

That he is Director of the Montana Department of Natural Resources and Conservation, the applicant for a license; that he has read the foregoing application and knows the contents thereof; and that the same are true to the best of his knowledge and belief.

Leo Berry

Montana Department of Natural Resources and Conservation

Subscribed and sworn to before me, this 20th day of May, 1982.

Donald D. McIntyre

Notary Public

My Commission expires: December 15, 1984

EXHIBIT A

DESCRIPTION OF THE PROJECT

EXHIBIT A

DESCRIPTION OF THE PROJECT

A.1 EXISTING FACILITIES

A.1.1 General

The proposed Broadwater Power Project would be located at Broadwater Dam. Broadwater Dam is located on the Missouri River in western Montana near the town of Toston. The dam site is situated approximately 21 miles downstream from the confluence of its headwaters on the Missouri River and approximately 30 miles south and upstream of Canyon Ferry Reservoir. Broadwater Dam is primarily a diversion dam for an irrigation canal system which serves the Toston area in Broadwater County. Water is diverted at Broadwater Dam for the irrigation of 20,000 acres. The total drainage area above the dam is slightly less than 15,000 square miles. The average annual volume of flow over the dam is about 3,700,000 acre-feet, and the average monthly flow is approximately 5,200 cfs.

The construction of Broadwater Dam was completed in 1940. Funding for the project was provided by the Public Works Administration, with assistance from the Montana State Water Conservation Board.

The Water Conservation Board maintained ownership of the dam until 1967. In that year, the Water Conservation Board was reorganized and became the Montana Water Resources Board. The Water Resource Board owned and operated the dam for the following four years. In 1971, under a general state reorganization, ownership of Broadwater Dam was transferred to the Montana Department of Natural Resources and Conservation (the Department), the current owner.

The dam operation is the responsibility of the Department in conjunction with a local water agency, the Broadwater-Missouri Water Users Association. The Association provides the on-site operational control and the Department performs overall supervisory functions.

A.1.2 Dam and Reservoir

Broadwater Dam is a concrete gravity overflow dam. Flow passes over seven ogee weir sections, each bay being 54 feet in width, for a total spillway length of 378 feet. The total length of the dam is 705 feet. The dam height, from the average ground level to the spillway crest, is 24 feet. Including the distance to the top of the retaining wall and pier structure, the total height is 40 feet.

The normal reservoir water surface elevation ranges from 3949 to 3952 feet above mean sea level (MSL), during the irrigation months. The maximum reservoir level would be about 3957.6 feet, MSL, which would occur during the 10,000-year flood. The storage capacity is tabulated below.

	Elevation (Feet, MSL)	Gross Storage (Acre-feet)
Below Dam Crest	3941.6	1500
Below Maximum Flashboard Level	3949.5	3300
Normal Maximum Irrigation Level	3952	4100
10,000-Year Flood Elevation	3957.6	6460

Recent investigations by the Department have been conducted to determine the condition of the dam and appurtenant facilities. Although certain inadequacies were noted in the canal system downstream of the diversion works, the dam was determined to be in good repair, with no apparent

deficiencies. The U.S. Army Corps of Engineers did not include Broadwater dam in their study of high-hazard dams in the state.

Soil borings, which were taken when the dam was originally built, reveal that the dam was constructed on a bedrock ledge of quartzite. A detailed analysis of structural stability will be submitted with the final project plans and design drawings. A preliminary discussion of structural stability and design characteristics of the dam is presented in "Exhibit F - Supporting Design Report", a separate volume of this Application. The available soil boring data are also included in this document.

A.1.3 Spillway and Flashboard System

The spillway crest elevation is 3941.6 feet, MSL. During the normal irrigation months of April through October, flashboards are installed in all seven bays to maintain the reservoir water surface elevation in the range of 3949 to 3952 feet, MSL. The flashboards fit into supports in each of the seven spillway bays, and raise the "crest" of the dam to a maximum of about 3949.5 feet, MSL. A 25,000 foot-long reservoir with a surface area of about 313 acres is created with the flashboards in place. The corresponding reservoir elevation with this condition is about 3950.2 feet, and the reservoir capacity is about 3600 acre-feet. The flashboards are removed after irrigation during the winter and spring when flood conditions are more likely. The proposed project would entail replacement of the flashboard system with radial gates to allow a more flexible operation.

A.1.4 Diversions

The irrigation diversion at Broadwater Dam is made through existing control gates located near the left abutment of the dam. An approach channel off the diversion reservoir conveys

flows to the intake structure. The invert of the intake structure is located at the same elevation as the spillway crest, 3941.6 feet, MSL. Control of the diversion is maintained by four 48-inch-by-84-inch slide gates. The historical operation of Broadwater Dam, in conjunction with the irrigation diversions, is as follows:

> On about April 26, the water is diverted down the canal to allow water use to begin on May 1. A staff gage at the irrigation canal inlet is used to determine whether the flashboards on the dam need to be adjusted. The upstream water surface elevation ranges between 3949 and 3952 feet, MSL, during the irrigation season. The flashboards are removed from all but the end two spillway bays in October, the end of the irrigation season. If high river flows greater than about 3952 feet MSL occur after the flashboards have been installed, the flashboards are removed and are not replaced until river flows decrease and the upstream water surface elevation is less than 3945.6 feet, MSL.

The construction of the power facilities at Broadwater Dam would include the replacement of the existing diversion works with a similar structure located at a higher elevation.

A.2 PROPOSED FACILITIES

A.2.1 General

The proposed Broadwater power plant, would utilize an apron-mounted configuration. It would consist of a 10-MW power plant with four vertical-shaft turbines mounted in an open-flume configuration on the downstream face and apron on the existing spillway structure. The installation would be designed so that spillway flood flows could pass through the

structure as necessary without significantly reducing the existing spillway capacity.

A.2.2 Apron-Mounted Turbine Configuration

The existing spillway consists of seven bays, each approximately 54 feet wide. Piers separate the sections of the ogee-crest spillway. With the proposed apron-mounted configuration, the two existing spillway bays near the left abutment would be split with a middle pier into a total of four bays, each proposed bay being approximately 24-feet wide. A turbine-generator unit would be mounted within each of the resulting smaller bays, with the turbine shaft located approximately 36 feet downstream of the spillway crest. In addition, the existing piers would be modified to provide support for the generator floor. The turbine case and draft tube would be encased in a concrete spillway extension. The existing spillway would be partially removed to provide a good bonding surface between the existing concrete and the new concrete. The generators and other appurtenant plant facilities would be located in a superstructure mounted on the modified existing piers and on the newly constructed piers above the downstream spillway. An inspection gallery would be included immediately downstream of the turbine, and a drainage and grouting gallery would be placed at the interface of the existing dam and the new structure.

The existing flashboard system used to increase the reservoir water surface elevation during the summer months would be removed. Additional piers identical to those proposed for the turbine bays would be constructed in the remaining five bays. Radial gates, approximately 24-feet wide by 12-feet high, would be installed in all bays. A new service bridge with a movable gantry crane would be added for maintenance access to the

gates. The bridge would be composed of precast T-beams, several of which could be removed when additional access is necessary.

In order to facilitate power production, it is proposed that the pool elevation be held at 3952.6 feet year-round under the normal range of flows in the river. This is a 1.6 foot increase over the normal operating elevation of the pool. At this elevation the reservoir would cover approximately 327 acres and extend about 26,000 feet upstream. This is an increase of 14 acres in area and 1000 feet in length over the existing reservoir at normal operating elevation. See Exhibit E for further discussions.

Since the turbine-generator units would be occupying spillway bays, it would be necessary for the turbine bays to be designed to pass flood flows directly through them. Splitter piers, in addition to the piers already discussed, would be constructed in the middle of each power bay with a fixed wheel gate spanning between the major piers and the splitter piers. The rear wall of the power bays would thus be removable. During periods of high flow, the turbines would be stopped, and the fixed wheel gates raised to allow unhindered passage of the flood flows through the turbine bays.

Trashracks would be included upstream of the existing dam crest. They would be removed by the upstream gantry crane when the turbine bays were converted to spillway bays during periods of high flows. A downstream, outside gantry crane would be included to facilitate fixed-wheel gate removal and for stoplog insertion when necessary.

The substation for the power plant would be located on the left abutment near the existing picnic area. Relocation of this picnic area is discussed in Exhibit E.

A new canal inlet structure would replace the existing structure on the left bank. The structure would be equipped with radial gates and would operate automatically to insure a uniform discharge.

The existing low-level outlets through the dam would be plugged with grout and the gates removed. These outlets have never functioned as planned and one gate is currently frozen in a half-open position.

A.3 POWER PLANT EQUIPMENT

A.3.1 Turbines

The type of turbine selected for the Broadwater Power Project is a vertical shaft propeller turbine. The selection was based on the physical constraints of the site. The low head requires a propeller turbine, and the placement of the unit on the downstream face of the spillway makes a vertical shaft unit the most suitable type.

The area of the inlet flume and the height of the water surface above the turbine entrance limits the size of the vertical turbine that could be installed and operated without vortices occurring in the entrance. Model tests (See Appendix A) established that vortices occur with a discharge of 1800 cfs through the turbine. A turbine with a maximum discharge of about 1500 cfs was therefore selected to provide a suitable margin of safety. The resulting turbine output at 22 feet of net head is 3350 hp at 180 rpm. Using these parameters, recommendations for turbine runner size were sought from turbine manufacturers. A standardized tube turbine runner with a runner diameter of 2750 mm (9 feet) was found to meet these requirements.

The turbine finally selected has an adjustable blade propeller runner with fixed guide vanes. The loss in power output from the fixed vanes, compared to the amount that could have been achieved by the use of movable wicket gates, is more than compensated for by the lower cost of the fixed vanes.

An economic analysis was conducted to determine the optimum number of turbines for installation at the project site. The choice of the optimum installation was based on the configuration that would produce the greatest present-worth benefit.

Cost estimates and average annual energy estimates were prepared for several combinations of unit sizes. Based upon the estimates, discounted cash flow analyses were performed for various assumed rates of inflation. The assumed rate of inflation over the project life was found to be the controlling factor in the optimization since increases in the value of energy are generally greater than increases in the project annual cost. This is due to the fact that the price of energy is very responsive to inflation, while annual hydroelectric costs, which are comprised mostly of fixed initial construction costs and, to a lesser extent only, of variable operating and maintenance costs, are not significantly affected by changes in the economy.

To summarize the results, it was determined that, for an assumed inflation rate under two percent per year, the three turbine installation was optimal. At two percent per year over the project life, the four unit option became optimal and, above seven percent annual inflation, the six unit installation became optimal.

Based on these considerations, it was decided that a reasonably conservative approach would be to assume an inflation rate of less than seven percent over the project life. The four turbine installation would therefore be the

recommended configuration. The total plant capacity would be 10.0 MW. If the inflation rate is such that in the ensuing years it proves economical to add more units, this could be easily accomplished.

A.3.2 Generators

Matching each of the turbines would be a speed increaser and a synchronous 2500 kW generator. Each generator would be rated at 2750 kVA, have a speed of 1170 rpm, and an output voltage of 2400 V. The generators would be set up for 3-phase, 60 hertz transmission. A main transformer, serving all four units, would be a 2.4/110 kV, 10/12.5 kVA, 3-phase type unit.

A.3.3 Appurtenant Equipment

The powerplant would also include such miscellaneous mechanical items as a water supply system, a heating and ventilating system, and fire protection and drainage systems; and such accessory electrical equipment as switchgear, wiring and cable systems, lightning arrestors, and lighting and communications systems.

A.4 TRANSMISSION FACILITY AND LINE

The powerplant would be connected by an approximately one-mile long, 100-kV transmission line to the existing 100-kV line owned by Montana Power Company and located near the former townsite of Lombard. This line will be able to transmit all the energy produced from the project.

A.5 OWNERSHIP OF LANDS

Ownership of project boundaries and surrounding land is shown in Exhibit G, which is part of this application. Current ownership was acquired in 1940 when Broadwater Dam was

constructed. Generally, the Applicant owns the riverbed and owns or has flood easements on all land up to elevation 3953.0 feet MSL, sufficient to accommodate a flow and backwater equal to the design spillway capacity of 50,000 cfs. Three parcels, however, have no title at present (two within Parcel 5 and one within Parcel 8, as shown on Exhibit G-1). The total acreage within the project boundary is 545 acres.

As shown on Exhibit G-1, the proposed project boundary extends to elevation 3960.0 feet MSL, the land necessary to accommodate a flow and backwater slope equal to the estimated spillway capacity of 76,200 cfs. This spillway capacity is the point at which the dam acts as a submerged weir and has no effect on upstream water surface levels. This area encloses some land owned by the U.S. Bureau of Land Management. The proposed transmission line extends from the north side of Broadwater Dam about 1.5 miles in a southeasterly direction to interconnect with Montana Power Company's line. A 200-foot wide right-of-way is shown for the transmission line. The breakdown of land ownership within the project boundary is shown below.

Owner	Parcels	Approximate Acreage
Applicant	1,9,16,17,river bottom and islands	280
BLM	2,6,7,12,13	44
Private	3,4,5,8,10,11,14,15,18,19,20,21	221

The tabulation of federal lands within the project boundary is presented below.

Parcel	Location
2	T4N, R3E, Section 6, SW 1/4 of SW 1/4
6	T4N, R2E, Section 12, NW 1/4 of NW 1/4
7	T4N, R2E, Section 2, SE 1/4 of SE 1/4
12, 13	T4N, R2E, Section 12, SW 1/4 of SW 1/4
Portion 13	T4N, R2E, Section 12, NW 1/4 of SW 1/4

The Applicant intends to submit a revised Exhibit G and legal description of ownership within one year of project startup.

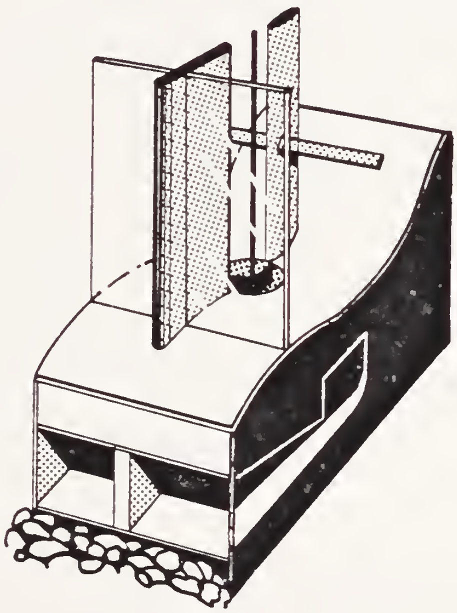
APPENDIX A

MODEL STUDY

PROJECT REPORT HRS 60-79

POTENTIAL HYDROELECTRIC POWER DEVELOPMENT INVESTIGATIONS FOR VERTICAL TURBINE-SPILLWAY COMBINE, BROADWATER DAM

HYDRAULIC MODEL STUDIES for TUDOR ENGINEERING CO.



by

Dr. A.B. Rudavsky

and

Wei-Yih Chow

February 1979

CONTENTS

PREFACE

Model investigations to hydraulically assess and experimentally develop the vertical turbine-spillway combine structure at Broadwater Dam were requested by the Tudor Engineering Company of San Francisco, to be performed by Hydro Research Science (HRS), Santa Clara, California.

The extent of the model study, its execution, and associated administrative procedures were discussed in terms of a two-dimensional system which would model one spillway bay of the Broadwater Dam and the vertical turbine-spillway combine structure, using a scale of 1:24, model to prototype. The testing program included two sets of tests, the first set of tests used a wide range of headwater-tailwater relationships to assess the broad spectrum of flow conditions used to bracket the operational scope of the proposed structure. This test series provided useful preliminary data for engineering planning and synthesis of the parameters which were investigated. The second set of tests incorporated the surveyed and verified tailwater rating curve and some changes in the basic geometric layout based on the preliminary testing program. This included a larger draft tube opening and recommended HRS modifications.

The project was divided into three stages: Stage 1 - construction of the model, Stage 2 - hydraulic testing of the model and experimental development of modifications, and Stage 3 - report writing. The first stage was completed in December 1978, the second phase was concluded in February, 1979, and the third phase was finished in March, 1979.

During the course of the model construction and model investigations, the model was visited by Messrs. Dave Willer, Gordon Little, Lemma Wendim-Agegnehu and Don Guild from Tudor Engineering Company; Mr. Rick Bondy from Montana Dept. of Natural Resources and Conservation; Dr. M. J. McLatchy, U.S. Department of Energy; Robert Pate, EG&G Idaho, Inc.; and G. R. Skopecek, Jr., Trident Engineering Company.

These gentlemen visited the model to discuss the testing program, to develop revisions and plans, and to correlate tests results with the engineering work currently performed by Tudor Engineering Company.

The layout, construction, modifications, and subsequent model investigations were conducted by personnel of Hydro Research Science, Santa Clara, California, under direct supervision of Dr. A. B. Rudavsky, with special assistance by Wei-Yih Chow.

SUMMARY

Model investigations for the hydraulic assessment and the experimental modifications of the Vertical Turbine-Spillway Combine Structure at Broadwater Dam were performed for the Tudor Engineering Company, by Hydro Research Science (HRS), Santa Clara, California. The model investigations were conducted to verify the hydraulic performances of the proposed design, to observe the complex flow conditions, and to develop the necessary modifications to alleviate any undesirable flow conditions revealed by the model study.

The model complex consisted of three main parts: The model of the structures, auxiliary appurtenances, and instrumentation.

The test program was divided into three main phases: Phase I, Base Test Studies; Phase II, Developmental Studies; Phase III, Verification Test Studies. In Phase I, tests of the proposed design under four different operational modes were investigated to evaluate the performances of the structure. Modifications were introduced in Phase II to correct the undesirable flow conditions. These recommended modifications were subjected to a rigorous examination in Phase III by again going through all operational modes and flow conditions. Satisfactory flow conditions were observed in the structure.

The testing program is summarized for quick reference in Table 1. All tests were conducted at the Hydro Research Science laboratory in Santa Clara, California.

PART I: INTRODUCTION

General

1. This report describes the construction, test sequences and test results of the hydraulic model studies of the Broadwater Dam Vertical Turbine-Spillway Combine Structure for Tudor Engineering Company. The model investigaions were performed to verify the hydraulic performance of the proposed turbine-spillway design, to develop any necessary modification of the design, and to alleviate any unacceptable flow conditions revealed by the model study.

2. This report consists of four major parts:

   I: Introduction
   II: The Model
   III: Description of Tests and Results
   IV: Illustrative Material

3. General information about the Broadwater Dam Vertical Turbine-Spillway Combine Structure was contained in the following:
   a. Drawings furnished by Department of Natural Resources, state of Montana;
   b. A sequence of sketches and drawings prepared by Tudor Engineering Company; and
   c. Communication regarding the design data and general information of the structure.

Project Description

4. The general layout of Broadwater Dam is shown in Plate 1. It is located on the Missouri River about seven miles southwest of the town of Toston in Broadwater County in the state of Montana on the Missouri River. The spillway section is an ogee concrete structure rising 24 ft from its base to its crest (El. 3941.6 ft). The normal operating head water surface elevation will be constant at 3952.6 ft with a maximum of 3957.0 ft during a 10,000 year flood. The tailwater elevation varied from El. 3927.1 ft to 3953.0 ft and was established using a rating curve supplied by Tudor Engineering Company.

System Description

5. The proposed modification to the dam structure consists of the addition of four to six power bays. Each bay would have a vertical shaft, low head turbine and generator unit, a movable gate to facilitate spillway operation, and a draft tube to allow the water to exit the power bay after passing the turbine vanes. Each power bay is 24 ft wide with a 3 ft thick wall separating each bay. The layout of one power bay includes two piers 3 ft thick located along the centerline of the power bay, one pier immediately upstream of the draft tube entrance, and the second pier immediately downstream of the draft tube entrance. Two gates located 15 ft downstream of the centerline of the turbine shaft were used to confine water during power generation. The gates were 10.5 ft wide, spanning the channel on either side of the pier downstream of the draft tube entrance. The draft tube entrance diameter was 10.78 ft at elevation 3929.4 ft and narrowed to a diameter of 9.2 ft in a vertical distance of 4.66 ft. The draft tube below the turbine vanes exits through a transition section from a single vertical circular shape to a double rectangular shape with a horizontal orientation before exiting the structure. Inside the horizontal section there was a gate used to block flow through the tube during operation as a spillway.

Need for Model Investigation

6. Although the design of the addition of the Vertical Turbine-Spillway Combine Structure to Broadwater Dam is in accordance with standard hydraulic practices, the withdrawal patterns through the draft tube and the projected hydraulic conditions in the area downstream of the structure are not susceptible to theoretical analysis. A number of uncertainties inherent in solely analytical determinations must be confirmed by model studies if reliable predictions of the suitability of individual designs for the various elements are to be made with confidence. The main elements of concern were: (a) the flow conditions and withdrawal patterns around the turbine entrance when generating power; (b) flow conditions through the power bay when operating as a regular spillway bay; and (c) flow conditions in the area downstream of the structure during flood conditions.

PART II: THE MODEL

Model Setup

7. The sectional model of the Vertical Turbine-Spillway Combine addition to Broadwater Dam was constructed to an undistorted linear scale ratio, model to prototype, of 1:24. The model was built to be flexible enough to make the components readily exchangeable if the need arose for major revisions to the model structure. The model consisted of four main parts:

   a. The experimental basin
   b. The model proper of the structure
   c. The auxiliary appurtenances
   d. Instrumentation

   Overall views of the model with auxiliary equipment and instrumentation during construction and after completion are shown in photographs 1, 2, and 3.

Model Description

8. The experimental basin encompassed an area of approximately 4 ft by 24 ft (photograph 1). The model basin was contained within a parallel-wall enclosure, with the inner enclosed area simulating a significant portion of the reservoir around the modeled section of the dam. The elevation in the model basin could be set at predetermined desired levels.

9. The model proper of the structure only simulated one power bay. Since the power bay structure is symmetrical about the centerline, the model was constructed in basically a mirror image. The model consisted of the significant approach area to the structure (the experimental basin), the dam crest, the draft tube entrance, the diffuser for the draft tube, and the proposed piers and gates within the power bay.

10. All key components were made of acrylic plastic to enable the experimenter to observe the flow pattern throughout the system. Only the nonessential parts in which transparency was not important were made of wood. The actual model components were augmented by

auxiliary equipment: a sump to store water, centrifugal pumps to circulate the water through the model, and a system of discharge valves and butterfly valves to regulate the flow to simulate the inflow conditions.

11. The major metering devices used in the model to measure elevations and velocities included manually operated point gages, current velocity meters, dye meters, and orifice meters associated with manometers to help determine the discharges. These instruments and their uses are briefly described in subsequent paragraphs.

12. Higher velocities were measured by a pygmy-type current meter. Subsurface current patterns were determined by means of dye introduced into the model at the desired depths. The dye meters employed in observing the flow pattern consisted of probes which could be immersed in the model to any desired depth and through which the dye was directed from the source of the probe.

Model Laws

13. The similitude relations between the model and the prototype for this type of model are based on the Froude Law. The resulting mathematical relationships between the basic hydraulic quantities of the model and the prototype are summarized in the following table:

Dimension	Ratio of Model to Prototype	Scale Relationships
Length	$L_r = \frac{L_m}{L_p}$	1:24
Area	$A_r = (L_r)^2$	1:576
Time	$T_r = (L_r)^{1/2}$	1:4.90
Velocity	$V_r = (L_r)^{1/2}$	1:4.90
Discharge	$Q_r = (L_r)^{5/2}$	1:2821.8
Roughness	$n_r = (L_r)^{1/6}$	1:1.7

The above scale relationships will be used to transfer quantitatively the discharge, depth of flow, and the velocity of flow from the model to the prototype.

14. In the report, (p) indicates prototype values, (m) applies to model values, and subscript (r) signifies the ratio of model to prototype. Unless otherwise designated or self-evident, the quantities given in this report refer to the prototype. Model data has been transferred to prototype equivalences by the scale relationships listed above.

Interpretation of Model Results

15. Similarity between the model and the prototype was obtained in accordance with the Froude Law, which assumes gravity as the dominant force. Since complete dynamic similitude and accurate reproduction of some properties of the prototype materials are not possible, some limitations must be imposed on the model results.

16. Measurements of discharge, water elevations, and velocities in the model can be transferred quantitatively to prototype equivalences without any reservations.

17. Since it is not feasible to reproduce the prototype roughness of steel or concrete surfaces in a plywood or acrylic plastic surfaced model of this scale, a slight decrease in conveyance efficiency of the model can result. A slight variation from the theoretical model roughness will have almost no effect on the performance of the flow in the model power intake structure or in the turbine throat and draft tube.

18. This two-dimensional model simulated only part of the whole system, therefore, it is of limited value for prediction and experimental analysis of the hydraulic interaction between adjacent regular spillway bay or power bay, especially for the flood mode conditions. These points will be discussed later in the report.

19. Data on scour are to be considered as qualitatively indicative since it has not yet been found practicable to reproduce quantitatively, in a model, the resistance to erosion of a prototype which has cohesive or rock bed material. Purely granular materials were used in the model and the erosion tests gave only comparative, rather than absolute, results.

20. Air entrainment cannot be modeled by the Froude Laws alone. Air entrainment is a function of the flow velocity, depth and distance traveled. At present, there is no acceptable method to correlate air entrainment between the model and prototype.

21. The segments of the draft tube and the motion of turbine were not simulated although vanes were included. Therefore, neither the prototype turbine nor a model scale relationship for the turbine was established. Instead, the properly scaled flow quantities were discharged through the draft tube to simulate the prototype discharges. Therefore, the model should be considered as representative only within the confines of the draft tube section. Obviously, well-distributed flow patterns observed in the modeled approach segments to the draft tube should assure flawless turbine performance so far as inflow conditions are concerned.

PART III: TESTS AND RESULTS

Scope of the Experimental Program

22. The general purpose of the model study was to determine the soundness of the hydraulic aspects of the proposed design and, if necessary, modify the design to improve any undesirable flow conditions revealed by the model tests. Tests were conducted to analyze hydraulic conditions in the following areas of concern: (a) discharge-head rating curve of the spillway; (b) the area above the draft tube entrance during the generation and combined operation modes; (c) the area immediately downstream of the model structure during the generation, combined operation and flood modes; and (d) flow through the structure during the flood mode. Close liaison was maintained with the client to ensure that the model investigations were practical in terms of design and construction and representative of site and operating conditions.

23. The experimental program was divided into four different modes according to the operation:

a. Pure generation mode:
This condition exists when the river flow, after irrigation diversion, is less than 5920 cfs. Depending on the magnitude of the available flow, one to four units would be generating power while all the spillway bays remained closed.

b. Combined operation mode:
When the range of flow at the site is between 5930 and 31400 cfs, all four units would be generating power and depending on the flow magnitude, one to nine spillway bays may be opened to bypass excess flow.

c. Controlled flood mode:
When the flow is between 32500 and 42800 cfs, generating power is terminated and the power bays are successively converted to spillways as needed.

d. Uncontrolled flood mode (surcharge mode):

In the event of rare floods (100 to 10,000-year floods) the surcharge space, from top of the embankment dam (El. 3957.6 ft) to the normal operating level (el. 3952.6 ft), will be utilized to facilitate their safe passage. Of course, all the gates will be fully open.

Table 4 shows the experimental program.

24. Base test studies were conducted first to assess the flow patterns in the power bay and downstream of the structure for the pure generation mode and the combined operation mode conditions. The preliminary investigations of the flood mode conditions were also conducted. The second phase, developmental studies, consisted of determinations of the most effective shape of the spillway section in front of the draft tube, the location of tailgate, and the head-discharge rating curve of the spillway. The third phase of the study was were verification tests. In this phase, the recommended modifications were optimized and verified through model tests.

25. The parameter specifications for the selected conditions to be tested were not available in their final form until late January, 1979. Therefore, two series of experimental tests were conducted to cover all possible conditions which could occur in the prototype. The first series of experimental programs (based on preliminary estimated parameters) is shown in Table 3 and the second one (based on best acquired information) is shown in Table 4.

26. In the second series of tests, the revised draft tube and the updated hydrological data were used. Due to time limitations of the project, and small variation in discharges, not all 22 cases were tested, but a sufficient number of selected case tests were performed to have enough data to make a reliable judgment.

Test Procedures

27. The test program consisted of two main operating configurations. The first configuration included the pure generation and combined operation modes with the tailgate closed and the flow going through the draft tube. The second configuration simulated the controlled

and uncontrolled flood modes with the tailgate open and the structure operating as a spillway. For the pure generation and combined operation modes, the test procedure was to reproduce the desired discharge through the draft tube and establish the desired headwater and tailwater elevations. Once the flow conditions were established, the following conditions were carefully monitored: The flow patterns in the power bay and downstream of the model structure were observed and recorded; any tendencies for vortices to form or any scour tendencies along the bottom downstream of the structure were also investigated. For the controlled and uncontrolled flood modes, the desired discharge and headwater elevations were set. Then the corresponding tailwater elevations were set using adjustable weirs. The flow patterns, water surface profiles, and general assessment of flow behavior upstream, over the structure and downstream of the structure were observed and analyzed and their suitability for the proposed "turbine spillway design" judged.

Data Presentation

28. The presentation of test data in this report does not follow the chronology of the experimental program. Instead, each of the experimental phases of the study is considered in turn. All tests conducted under the revised testing program are described with the appropriate phase.

Phase I: Base Test Studies

29. Base tests were conducted to establish a base for comparison and to indicate the extent and direction of the model study. In this particular study, there were two sets of base data tests. The first set of tests used a wide range of headwater-tailwater relationships to assess the broad spectrum of flow conditions used to bracket the operational scope of the proposed structure. This test series provided useful preliminary data for engineering planning and synthesis of the parameters which were investigated (Table 3). The second set of tests incorporated the surveyed and verified tailwater rating curve and some changes in the basic geometric layout based on the preliminary testing program (Table 4). This included a larger draft tube opening and the HRS modifications that had been developed to that point.

30. The first set of base test studies were divided into three modes of operation: 1) pure generation; 2) combined operation; and 3) flood mode. The first two operating modes required the tailgate to be closed and the discharge to flow through the structure via the draft tube. When operating the model in the flood mode the tailgate was removed and the draft tube gate was closed.

31. Base test model observations for the generation and combined operation modes were directed at the area above the turbine entrance and the area downstream of the structure. Model observations using three representative discharges and corresponding headwater and tailwater elevations for the first set of base studies, with the model operating in the generation mode, indicated that the area above the throat of the turbine exhibited some undesirable flow characteristics including eddies and dimples on the surface. Observation of the flow pattern in this area revealed two large eddies, one on either side of the channel. The eddy depressions moved away from the downstream side of the pier upstream of the turbine entrance (Plate 5). The blunt nose of the pier appeared to contribute to the formation of these eddies. The flow pattern over the ogee section and above the turbine intake, displayed eddy patterns and nonuniform approach conditions. However, the pattern could be easily changed through modeling strategic modifications of the approach geometry. The observations of the downstream flow conditions showed typical outflow pattern from a diffuser structure under submerged conditions (Plates 6, 7, 8 and 9). The flow conditions were judged satisfactory and for final design, velocity measurements should be taken to assess the need, or degree of protection downstream of the structure.

32. Observations of the model during the base tests in the flood mode ranged from very low to very high tailwater conditions with the lower tailwater conditions definitely outside the range of Broadwater Dam tailwater conditions. This was done to properly assess the gamut of flow conditions and to judge the sensitivity of these conditions to the changes in tailwater. Discussion of the first base tests of the model in the flood mode has a broad base and will be included in a generalized assessment at the end of the report.

33. The tailwater rating curve which was obtained using the surveyed data of the prototype placed all flow conditions for Broadwater Dam into a submerged jump condition. This condition will be discussed in subsequent paragraph.

34. For the controlled flood mode, the model was observed with a constant discharge of 3100 cfs and a headwater elevation of 3952.6 ft with two tailwater elevations of 3941.8 ft and 3944.3 ft. Under these conditions, the hydraulic jump was contained within the structure with a high velocity jet downstream of the jump that remained about 10 ft below the surface. When tailwater was set at 3941.8 ft, the maximum jet velocity was 10.65 ft/sec 30 ft downstream of the structure. When the tailwater was raised to El. 3944.3 ft, the maximum jet velocity was 11.14 ft/sec 10 ft downstream of the structure (Plates No. 10 and 11).

35. Velocity measurements and the scour pattern in the erodible material were used to assess the energy dissipation problem downstream of the spillway structure. The overall assessment indicates that for final design the geologic structure in the downstream riverbed, the existing energy dissipators, and flow conditions under different recurrence intervals must be evaluated and the need or the design of an energy dissipator decided upon (Photograph 5). Also, at that stage of the design, the three dimensional aspects of the downstream flow conditions should be considered.

36. During the two-test series of base studies, the first series bracketed the broad range of problems that could be encountered for hydraulic conditions for Broadwater Dam modifications; the second series addressed itself to preliminary design considerations within the projected operating range of Broadwater's modifications. Findings of the first series lead to scoping of the total program and to some changes for the second test series. It also provided the needed input into the overall assessment which is given at the end of the report.

37. The second test series identified the problematic areas for the defined range of the Broadwater Dam and gave guidance for improvements to be experimentally explored. The problematic areas of concern were:
1) the establishment of a discharge rating curve; 2) the shaping of the downstream dam face; 3) the shape of the piers; 4) the location of the tailgate; and 5) assessment of energy dissipation problems.

Phase II: Developmental Studies

38. The developmental test series was based on indications developed and conclusions reached during the first series of base tests of the proposed design. The plan concentrated on the interrelated flow conditions over the ogee section and into the turbine during the generation mode.

39. The data needed and modifications of practical value for genertion mode can be grouped into the following broad classifications: a) establishment of discharge rating curve over the existing ogee section; b) modifications to the power bay to improve approach conditions to the turbine; and c) assessment and optimization of the shapes and location of the auxiliary structures inside the power bay and the tailgate.

40. Tests were conducted through using the flood mode configuration range of flows to establish the discharge rating curve for the existing ogee section. The model test results were in close agreement with computational results after checking the existing ogee section profile to presently accepted standardized designs. The head-discharge relationship obtained from the model studies is shown in Table 2.

41. Model studies were conducted to establish the most efficient transition connecting the downstream face of the ogee section with the floor of the power bay. The best fit curve was experimentally determined and is shown in Plate 3 and Photograph 4.

42. Tests to compare the efficiency of a streamlined pier nose and a semicircular nose were conducted on the pier immediately upstream of the turbine entrance. The separation of flow, and the formation of eddies and dimples around the downstream edge of the semicircular nose pier was eliminated. However, occasional eddies moved off the downstream edge of the pier. When operating the model as a spillway, the "streamlined" pier shape changed the flow patterns around the pier by eliminating the riding-up effect on the pier. It also directed the inflow patterns into the turbine shaft under the controlled flood mode (Plate 5 and Photograph 6).

43. A series of tests was conducted to optimize the location of the tailgate by moving the tailgate further upstream from its original location, 15 ft downstream of the centerline of the turbine shaft. During the investigation, the tailgate was moved to a position 7.5 ft downstream of the centerline of the pier. The model was observed in the generation mode. The flow patterns indicated that the eddies that form on either side of the structure became more intense. It appears as though the original position of the gates was satisfactory.

44. Once a streamlined approach and inflow conditions into the turbine were obtained, the structure was tested beyond the intended withdrawal rate to assess the limits when vortexing would be initiated. Such a technique was used due to the unstable characteristics of the vortex phenomena and to assess the degree of conservatism in the design. The experiments were conducted using a range of discharges from 1108 cfs to 1600 cfs.

45. As the model studies proceeded with the first series of tests, Tudor Engineering Company was conducting prototype tailwater investigations. Their prototype survey produced a revised tailwater rating curve and a new draft tube opening dimension. From this revised data, HRS began a new series of tests using a revised draft tube throat opening of 9.2 ft (original dimension was 8.0 ft) and a revised tailwater rating curve. The revised testing program is shown in Table 4.

46. In the preliminary studies, tests were conducted to establish an energy dissipation system to be used during controlled flood mode operation that would improve flow conditions and possibly eliminate any tendency to scour the channel bed. The tests were limited to overflow weirs located in the area between the downstream pier and the wall of the structure. The results indicated that a weir of 4 ft to 6 ft high may improve the flow conditions. The second series of tests, because of high tailwater conditions, no apparent improvement in flow conditions resulted with these weirs. The results of these tests are shown on Plate 12.

47. Model observation using the revised testing program indicated that the flows above 1250 cfs, required the addition of some sort of vortex spoiler. A single guide beam was placed on each side of the upstream pier with the leading edge kept at El. 3952.6 ft and inclined at various angles. An angle of 45° was found to be the optimum for eliminating the vortex formations (Photograph 7). A series of tests were conducted on the configurations in the generation and combined operation modes. Observation indicated that the beams directed the flow into the draft tube effectively and the small roller was of sufficient magnitude to prevent the formation of the eddy pattern in the area above the draft tube entrance (Plate 6, 7, 8 and Photographs 7-11). With the vortex spoiler in place, a maximum discharge of 1800 cfs can be discharged through the turbine without vortices forming. However, due to the limitation of modeling, certain safety factors should be imposed on the results.

<u>Phase III</u>: <u>Verification Tests</u>

48. Having evolved the final recommended design in the previous test phase, and on the basis of construction and economic considerations, the recommended design was modeled and subjected to a series of tests including three different modes of operation. The details of the recommended design are shown on Plate 4.

49. Since the flow characteristics had been defined in the previous phase of study, the main objective of this test series was to verify the effectiveness of the recommended modifications to the proposed design. The test results showed that the recommended modifications were hydraulically effective and the hydraulic performances for different modes of operation were satisfactory.

50. During the conditions of flood mode operation, one point of concern was the clearance between the water surface profile and the lowest point of the anti-vortex guide beams. As tailwater was progressively raised, and the corresponding discharge increased, the hydraulic jump moved up into the power bay (Photographs 12, 13, and 14) and the distance between the beams and the water surface decreased until the minimum distance was reached for the 10,000-year flood conditions. Under these conditions the minimum clearance was 3.4 ft. Plates 10 and 11 shows the water surface profile and the beam.

Discussion of Results

51. In general, the proposed design of the structure was satisfactory, only minor modifications need to be done where the pure turbine generation and combined operation modes are concerned.

52. The flow patterns in the power bay during the pure generation mode and combined operation modes are satisfactory for the recommended design (Photographs 7-11).

53. The bottom of the anti-vortex beams is at elevation 3951.2 ft. It is suggested that the turbine be operated only when the water surface is above 3950.0 ft to keep the generation unit safe.

54. The streamlined pier reduced the tendency of formation of eddies and vortices.

55. The tailgate position is important to the withdrawal pattern through the draft tube. There is a definite withdrawal area above the entrance of the draft tube which has been defined by this model study (Photograph 7).

56. The section of the spillway shape in front of the draft tube is important to the flow approaching the draft tube (Photograph 4).

57. The following factors are important to the hydraulic performances of the structure:

   a. The hydrological data regarding flood discharge and tailwater information, and hydraulic condition of the approach to the dam are basic design information for the structure. The model tests were conducted based on this information. Therefore, sufficient and updated data will help properly design the structure;

b. The choice of the size and type of turbine is important to the hydraulic structural design; and

c. One important factor affecting the hydraulic performance of the structure is the head difference between upstream water surface and tailwater elevations, because the discharge through the draft tube is partly a function of the head difference.

58. Since this model only simulated one power bay, it only reflected two-dimensional characteristics of the phenomena. Some limitations must be imposed on the model test results, also the results regarding the three-dimensional aspects have to be interpreted carefully.

59. One important three-dimensional hydraulic phenomena in this model was the hydraulic condition immediately downstream of the structure.

a. Conditions of pure generation and combined operation mode:

The flow through the draft tube discharged downstream of the structure into a dead water area. Because of the dynamic behavior of the jet, it oscillated and could have a tendency to cause scour on the river bottom. (The amount of scour which will occur in the prototype will depend on the insitu bed materials.)

b. Conditions of flood mode:

During the flood condition, the power bay will serve as regular spillway bay. Flow discharges over the spillway and a hydraulic jump will occur in the power bay and due to instability of the flow, the flow may cause scour at the toe of the dam (Photograph 5). The flow patterns for different conditions are shown in Plates 10 and 11.

Conclusions

60. The results of the model tests indicate that the conceptual design for changing the spillway into a power bay operating unit for Broadwater Dam is favorable and feasible from a hydraulic point of view and easily executed with minimal changes to the system. The preliminary studies coupled with suggested modifications, indicate satisfactory flow conditions under all modes of operation.

61. The scope of the experimental study involved the assessment and hydraulic solution to two key flow conditions: a) flow over the crest, withdrawal of water through the turbine, subsequent discharge downstream during power operation mode, and b) flow over the modified spillway section under flood mode. Both flow conditions, after the introduction of modifications, were found satisfactory and did not pose any insurmountable hydraulic problems in the final design.

62. Flow conditions under the generating mode displayed uniform overflow over the ogee section and streamlined approach motion to the turbine throat. No vortexing or adverse eddying pattern was present. These excellent approach conditions had been created by steamlining the auxiliary structures in the power bay, optimizing the location of the tailgate and providing a crossbeam which acted as a guide vane and assured prevention of vortexing at a considerable margin of safety. The flow plume outflow pattern beyond the draft tube displayed typical effluent emergence under high tailwater conditions.

63. Flow conditions under the flood mode displayed a typical submerged hydraulic jump under high tailwater conditions at an abrupt drop. Such flow conditions were characterized by two large rollers above and below the drop. The velocity distribution under such characteristics in the downstream region displayed higher velocities at the surface than on the bottom.

64. It is recommended that when the feasibility stage of this project progresses to the design stage, the following aspects be experimentally investigated and optimized for final design: a) under operation mode the velocity in the draft tube exit area be evaluated to assess the erosional potential of geologic formation and bottom quality of the riverbed; b) optimize the location of the guide beam and its configuration from structural construction and maintenance point of view; c) under flood mode, study further and analyze the submerged hydraulic jump behavior with respect to possible adverse pressure fluctuations, energy dissipation measures and stablization of the phenomena; and d) special shaping or protective cover arrangement for turbine intake should be investigated and seriously

discussed with the turbine manufacturer. It is standard HRS practice that in any dynamic condition pressure fluctuations are measured in the model. This technique is expedient and very valuable to the designer and structural engineer.

65. Also, for both operational and flood modes the three-dimensional aspects of the merging flows should be investigated during design stage. For these studies a two-dimensional setup as used in present studies can be utilized but a two or three bay configurations should be modeled. Such an arrangement does not involve great effort on the part of the laboratory.

<u>General Observations Applicable to Other Locations</u>

66. In consideration of the large amount of experience of Tudor Engineering Company in the modification of small dams into hydroelectric developments, and the hydraulic expertise in dam design and energy dissipation of Hydro Research Science, a general assessment and hydraulic background is provided here for the conceptual technique of transforming spillway bays into power bays. The discussion is drawn upon from the expertise and the wide range of generalized studies done under this contract.

67. There are two key flow conditions that the designer must deal with: a) the operational mode where the flow is guided over the ogee section into the confined space above the turbine, to assure vortex-free uniform approach conditions to the turbine and good performance of the turbomachinery, and b) the flood mode where the flow is effectively conveyed over the spillway and provided with an effective energy dissipation system.

68. The solution to flow conditions under operation modes is dependent upon geometric conditions within the structure, and at the present time, must be solved through physical modeling. A generalized study could be undertaken to standardize such a confinement. However, experienced experimenters must be employed. The preliminary generalized investigations indicate that there is great sensitivity to vortex formation due to geometric changes, opening changes or discharge and elevation changes. It appears that under certain circumstances, such as the final conditions of this study, that

some vortex inhibiting device similar to one suggested in this report may have to be employed. The suggested vortex suppresser has been used effectively by HRS and has been verified in prototype installations.

69. The solution to flow conditions under flood mode conditions presents more difficult problems since the flood flows over that type of structure display a number of different flow patterns under different tailwater conditions which differ in character. Therefore, several different solutions must be applied dependent upon the tailwater conditions. The most difficult condition to handle is at minimum tailwater which is subject to great erosional potential downstream of the structure.

TABLES AND ILLUSTRATIVE

MATERIALS

TABLE 1: SUMMARY OF EXPERIMENTAL PROGRAM AND RESULTS (page 1 of 6)

Test Series	Geometric Conditions	Hydraulic Conditions	Summary of Experimental Findings	References
PHASE I: BASE TEST (original testing program)				
Base test	Spillway gate closed, no material in section to be modified.	Q = 436 T.W. 3924.3 Q = 1180 cfs T.W. 3925.4 H.W. El. 3952.6 in both cases	Flow patterns indicate that a simple curve, tangent to the end of the existing ogee section and to the floor at the edge of the draft tube pipe would be sufficient for good flow conditions.	
	Tailgate closed, ogee section filled, no other modifications.	Q = 1000 cfs H.W. 3952.6 T.W. 3937.6 Q = 1103 cfs H.W. 3952.6 T.W. 3931.0 Q = 1180 cfs H.W. 3952.6 T.W. 3925.4	Flow patterns show eddies are present on either side of the center pier but no vortices were observed to enter the draft tube. Eddies caused by separation are present around the trailing edge of the center pier. Some dead area was observed upstream of the tailgate. Modified section of ogee appears to perform quite well.	T.S. 31 Pl 5
	Tailgate open	Q = 3360 cfs H.W. 3953.0 T.W. 3937.6 Q = 3360 cfs H.W. 3953.0 T.W. 3931.0	High velocities through structure (super critical flow). Jet continues into tailwater causing scour to riverbed. Velocities taken in the jet (max.) at a distance of 30 ft from the end of the structure were 12 fps for T.W. 3920 and 16.8 fps for T.W. 3913.	T.S. 32

SYMBOLS

Q = Discharge cfs
HW = Headwater
T.W. = Tailwater

T.S. = Text section
Pl = Plate No.
Ph = Photograph No.

TABLE 1: SUMMARY OF EXPERIMENTAL PROGRAM AND RESULTS (page 2 of 6)

Test Series	Geometric Conditions	Hydraulic Conditions	Summary of Experimental Findings	References
PHASE II: DRAFT TUBE ENTRANCE CONDITIONS				
Gate placement	Tailgate moved to 7.0 ft from centerline of turbine shaft.	Q = 1000 cfs T.W. 3937.6 Q = 1103 cfs T.W. 3930.6 Q = 1180 cfs T.W. 3914.6	By moving the gate upstream from its original position the flow patterns indicate that the eddies on either side of the pier become stronger with intermittent depressions showing up on the surface.	T.S. 43
Streamlined pier	Tailgate 15.0 ft downstream of centerline of turbine shaft, existing pier modified.	Q = 1103 cfs T.W. 3930.6	Flow conditions around pier shows some improvement over blunt nosed pier, weaker eddy near trailing edge, more symmetric flow pattern on surface.	
	Tailgate 15.0 ft downstream from centerline of turbine shaft. New pier installed.	Q = 1103 cfs T.W. 3931.0 H.W. 3952.6	Flow conditions appear to be improved over the previous streamlined pier, flow is nearly symmetric, very small eddies coming off trailing edge. There is still a roller near the bottom over the modified ogee section.	T.S. 42 Pl 5
Additional discharge through draft tube	Tailgate 15.0 downstream from centerline of turbine shaft, streamlined pier.	Q = 1600 cfs T.W. 3930.6 H.W. 3952.6	Flow patterns should intermittent vortices in three separate areas, from trailing edge of pier and in areas on either side of the draft tube opening.	T.S. 44
		Q = 1500 cfs T.W. 3930.6 H.W. 3952.6	The areas that had vortices with 1600 cfs discharge now have only intermittent dimples with a Q = 1500 cfs.	

TABLE 1: SUMMARY OF EXPERIMENTAL PROGRAM AND RESULTS (page 3 of 6)

Test Series	Geometric Conditions	Hydraulic Conditions	Summary of Experimental Findings	References
PHASE I: REVISED BASE TEST (pure generation mode)				
	Streamlined pier. Tests, with new data were picked up at the same stage of development as were left with development of the pier. Tailgate closed.	Q = 1580 cfs H.W. 3952.6 (case A) T.W. 3927.1	Strong vortex tendencies, depressions in area above draft tube entrance.	T.S. 47 Pl 6 Ph 6
		Q = 1896 cfs H.W. 3952.6 (case A) T.W. 3927.1. (case A + 20% Q)	Deep depressions with occasional vortex reaching draft tube entrance.	T.S. 47
		Q = 1480 cfs H.W. 3952.6 (case D) T.W. 3931.0	Depressions, strong tendencies, very intermittent vortex was observed reaching to draft tube entrance.	T.S. 47
PHASE I: REVISED BASE TEST (combined operation mode)				
	Streamlined pier, tailgate closed.	Q = 1430 cfs H.W. 3952.6 T.W. 3932.4	Depressions present in area on either side of draft tube entrance. Roller above draft tube exit from end of structure. No scour was observed.	Pl 7 T.S. 47
		Q = 1250 cfs H.W. 3052.6 (case H) T.W. 3936.4	Eddies with intermittent depressions present on either side of draft tube entrance. Roller above draft tube exit. No scour.	T.S. 47 Ph 9
		Q = 1050 cfs H.W. 3952.6 (case L) T.W. 3940.4	Eddies with small intermittent depressions present on either side of draft tube entrance. Roller above draft tube exit. No scour observed.	T.S. 47 Pl 8

TABLE 1: SUMMARY OF EXPERIMENTAL PROGRAM AND RESULTS (page 4 of 6)

Test Series	Geometric Conditions	Hydraulic Conditions	Summary of Experimental Findings	References
		PHASE I: Revised Base Test (combined operation mode)		
	Streamlined pier, tailgate closed.	Q = 990 cfs H.W. 2952.6 T.W. 3941.6	Slow eddies, on either side of draft tube entrance, no depressions were observed. Roller above draft tube exit. No scour downstream.	T.S. 47 Pl 9
		PHASE I: REVISED BASE TEST (controlled flood mode)		
	Streamlined pier, tailgate open.	Q = 3100 cfs H.W. 3952.6 (case Q) T.W. 3941.8	Super critical flow as water goes over the crest. Hydraulic jump is contained within the structure, approximately 6 ft to 7 ft downstream of centerline of turbine shaft. Velocities downstream of structure indicate the highest velocities stay near the surface about d = 10 ft (10.65 ft/sec) with velocities near the bottom between 2 and 4 ft/sec.	T.S. 34 Pl 10 Ph 12
		Q = 3100 cfs H.W. 3952.6 (case T) T.W. 3944.3	Super critical flow downstream of the crest. Hydraulic jump contained within the structure approximately 4 ft up-stream of the centerline of turbine structure. Downstream velocity profile shows a high velocity jet about d = 10 ft (11.14 ft/sec). Jet appears to be pretty well diffused by the time it is 50 ft downstream of end of the structure. Velocities near bottom are about 2 to 3 ft/sec.	Pl 10 Ph 13 T.S. 34

TABLE 1: SUMMARY OF EXPERIMENTAL PROGRAM AND RESULTS (page 5 of 6)

Test Series	Geometric Conditions	Hydraulic Conditions	Summary of Experimental Findings	References
PHASE I: REVISED BASE TEST (uncontrolled flood mode)				
	Streamlined pier, tailgate open.	Q = 3650 cfs H.W. 3953.6 T.W. 3945.9	Super critical flow downstream of the crest. Hydraulic jump located near leading edge of streamlined pier. Same base velocity distribution as previous test with highest velocities of d = 10 ft (11.67 ft/sec).	Pl 11 Ph
		Q = 5360 cfs H.W. 3957.6 T.W. 3952.0	Super critical flow downstream of the crest. Hydraulic jump located upstream of pier. Velocity profile shows highest velocity of d = 10 ft to d = 20 ft (17.5 ft/sec) with velocities near the bottom are from 2.51 to 2.72 ft/sec.	Pl 11
PHASE II: DEVELOPMENTAL TEST (flood mode)				
	4 ft weir on flood of structure, 15 ft downstream of centerline of turbine shaft.	Q = 3100 cfs H.W. 3952 T.W. 3941.8	Hydraulic jump is moved upstream to a position 12 ft upstream of centerline of turbine shaft. A second smaller jump is located 20 ft downstream of the end of the structure. Scour pit noted 25 to 30 ft downstream of end of structure about 2 to 3 ft deep.	T.S. 46 Pl 12
	6 ft weir on floor of structure, 15 ft downstream of centerline of turbine shaft.	Q = 3100 cfs H.W. 3952.6 T.W. 3941.8	Hydraulic jump is moved upstream to a position 16 ft upstream of centerline of turbine shaft. Second hydraulic jump located 20 ft downstream of end of structure. Scour pit noted in same position as previous test.	

TABLE 1: SUMMARY OF EXPERIMENTAL PROGRAM AND RESULTS (page 6 of 6)

Test Series	Geometric Conditions	Hydraulic Conditions	Summary of Experimental Findings	References
			PHASE III: VERIFICATION TEST (generation mode)	
	Final design, guide beam installed.	Q = 1580 cfs T.W. 3927.1 H.W. 3952.6	The beam creates a back roller on the surface which eliminates the eddy flow pattern, and the depressions, The effect of the beam seems to be limited to very near the surface with the lower levels remaining the same as without the beam.	T.S. 52, 53, 54 Pl 6 Ph 7
		Q = 1430 cfs T.W. 3932.4 H.W. 3952.6	Same effect as previous experiment but small eddies show up downstream of beam with intermittent small depressions.	Pl 7 T.S. 52, 53, 54
		Q = 990 cfs H.W. 3952.6 T.W. 3941.6	Slow eddies on either side of pier just downstream of the guide beams.	Pl 9 Ph 8 T.S.52,53,54
			PHASE III: VERIFICATION TEST (flood mode)	
	Streamlined pier, tail-gate open. Guide beams installed.	Q = 5360 cfs H.W. 3957.6 T.W. 3952.0	Profile shows 3.4 ft of clearance below guide beams.	Pl 11 T.S. 50

TABLE 2: Spillway H-Q Curve

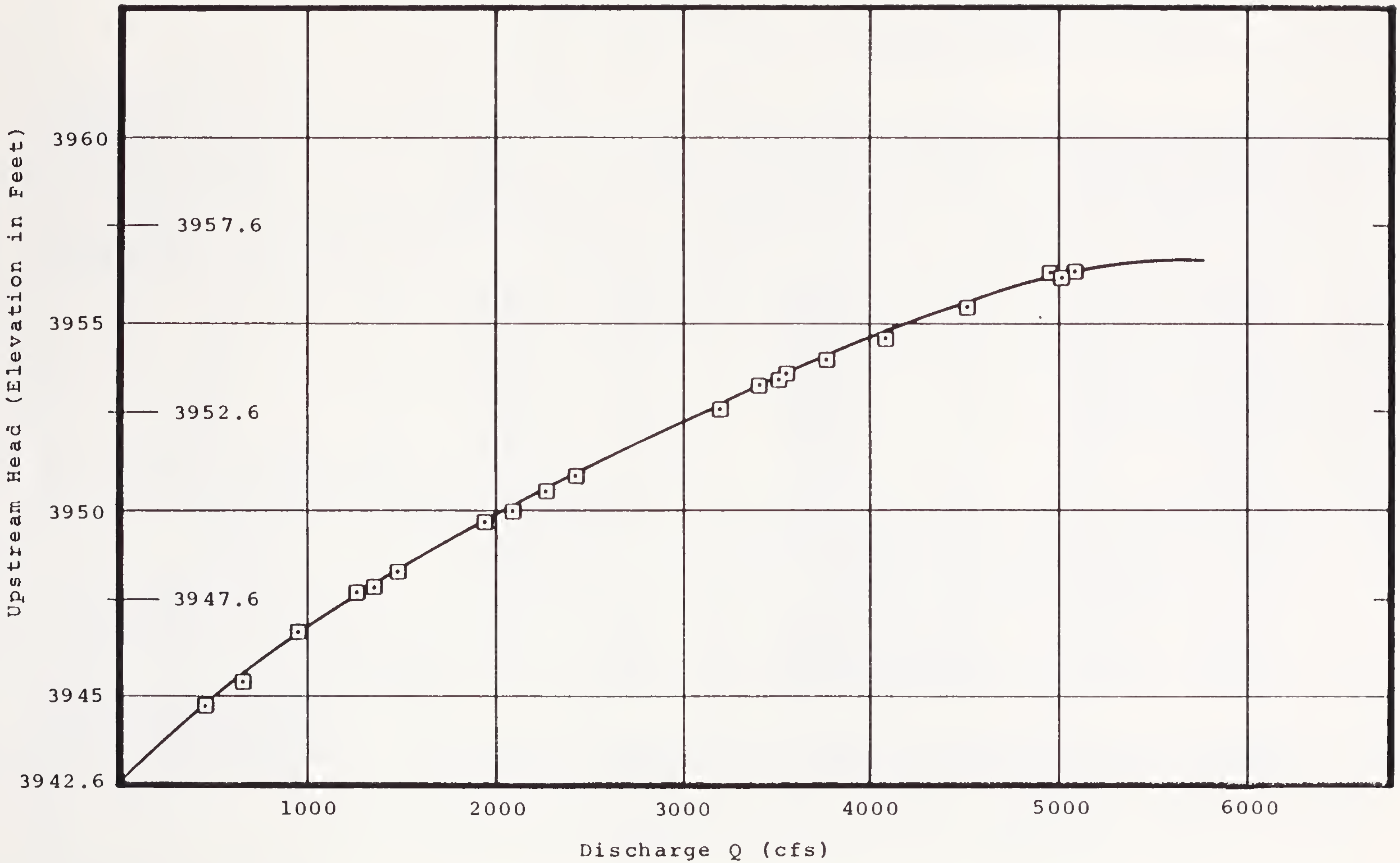


TABLE 3: ORIGINAL TEST CASES

Case #	Description	Discharge			Elevation		Head	
		1 Turbine	1 Spillway Bay	Total	Headwater Surface	Tailwater Surface	Turbine	Spillway
I	Pure generation mode							
1	Oper. 1 variable pitch turbine	436	0	436	3952.6	3924.3	28.3	-
2 a.	Oper. 1 fixed blade turbine	1180	0	1,180		3925.4	27.2	-
b.	" 2 " " "	1162		2,324		3926.7	25.9	-
c.	" 3 " " "	1148		3,444		3927.6	25.0	-
d.	" 4 " " "	1137		4,548		3928.4	24.2	-
e.	" 5 " " "	1129		5,645		3929.0	23.6	-
f.	" 6 " " "	1115		6,690		3930.1	22.5	-
II	Combined operation mode							
3 a.	6 turbines + 1 spillway bay	1103	3360	9,980		3931.0	21.6	11.0
b.	" + 2 " "	1084		13,224		3932.2	20.4	
c.	" + 3 " "	1072		16,512		3933.2	19.4	
d.	" + 4 " "	1062		19,818		3934.1	18.5	
e.	" + 5 " "	1049		23,094		3935.0	17.6	
f.	" + 6 " "	1034		26,364		3935.9	16.7	
g.	" + 7 " "	1017		29,622		3936.8	15.8	
h.	" + 8 " "	1000		32,880		3937.6	15.0	
III	Flood mode							
	5 turbines & 8 spillway bays							
	+ 1 power bay							
a.	Initial condition	984	3107	32,880	3952.0	3937.6	14.4	10.4
b.	Maximum discharge capacity	"	3360	35,180	3952.6	3938.2	"	11.0

TABLE 4: REVISED CASES

Case #	Description	Discharge (cfs)			Frequency (years)	Elevation (ft)		Head (ft)	
		1 Turbine	1 Spillway Bay	Total		Headwater Surface	Tailwater Surface	Turbine	Spillway
I	Pure generation mode								
1	Shutdown	<460							
a.	Oper. 1 var. pitch turbine	515-1580	closed	515-1580	never	3952.6	3925.0-3927.1	27.6-25.5	closed
b.	" 2 " " "	510-1560		1020-3120	occurred		3926.2-3928.8	26.4-23.8	
c.	" 3 " " "	510-1520		1530-4560			3927.0-3930.0	25.6-22.6	
d.	" 4 " " "	510-1480		2040-5920			3927.6-3931.0	25.0-21.6	
II	Combined operation mode								
2a.	4 turbines + 1 spillway bay	1430	2630	8350	1	3952.6	3932.4	20.2	11.0
b.	" " " 2 " "	1370	2860	11200			3933.8	18.8	
c.	" " " 3 " "	1310	2936	14048			3935.2	17.4	
d.	" " " 4 " "	1250	2974	16897			3936.4	16.2	
e.	" " " 5 " "	1190	2997	19745			3937.5	15.1	
f.	" " " 6 " "	1140	3012	22634			3938.6	14.0	
g.	" " " 7 " "	1090	3023	25522			3939.6	13.0	
h.	" " " 8 " "	1050	3031	28451			3940.4	12.2	
i.	" " " 9 " "	1010	3038	31380	14		3941.2	11.4	
j.	0 " "10 " "	-	3043	30428	12		3941.0	11.6	
k.	1 " " " " "	1010	"	31438	14		3941.3	11.3	
l.	2 " "10 " "	990	"	32408	17		3941.6	11.0	
III	Controlled flood mode								
3a.	10 spillway bays + 1 power bay		3047	33516	20		3941.8	shutdown	
b.	" " " " 2 " "		3050	36605	33		3942.7		
c.	" " " " 3 " "		3053	39694	53		3943.5		
d.	" " " " 4 " "		3056	42782	91		3944.3		
IV	Uncontrolled flood mode								
	10 spillway bays + all	-	3534	49478	250	3953.6	3945.9	-	12.0
	power bays	-	5670	79380	10,000	3957.6	3952.0	-	16.0

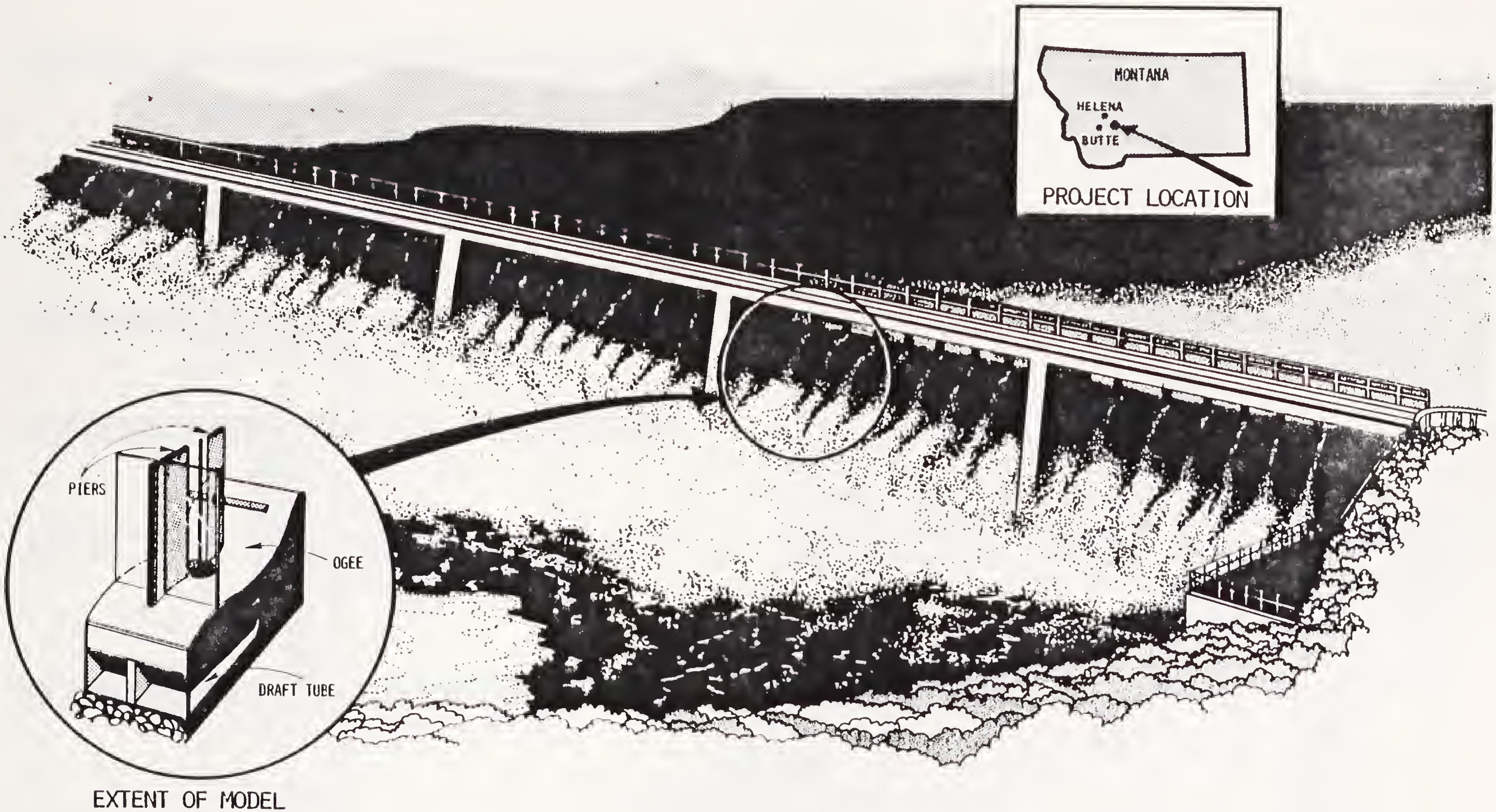
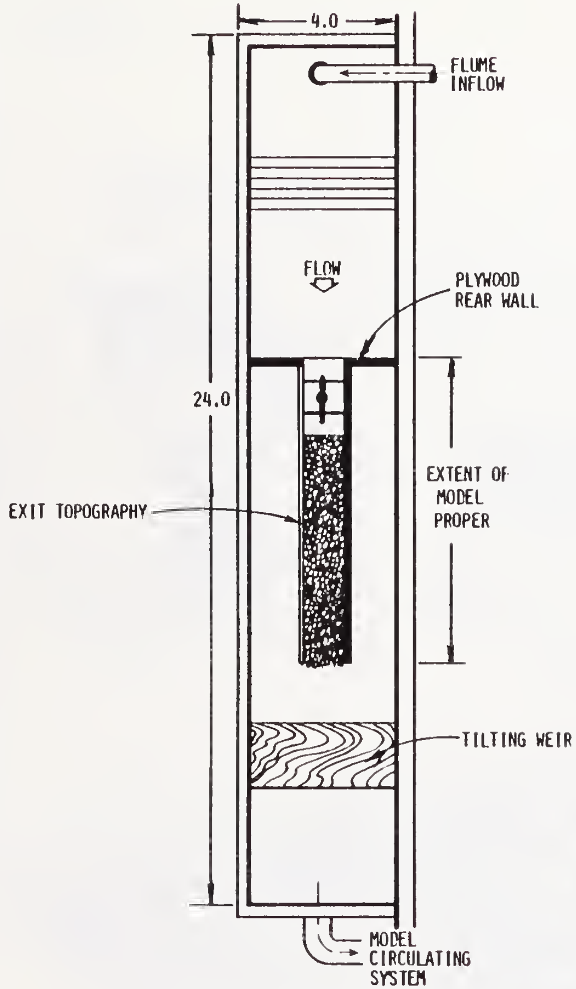
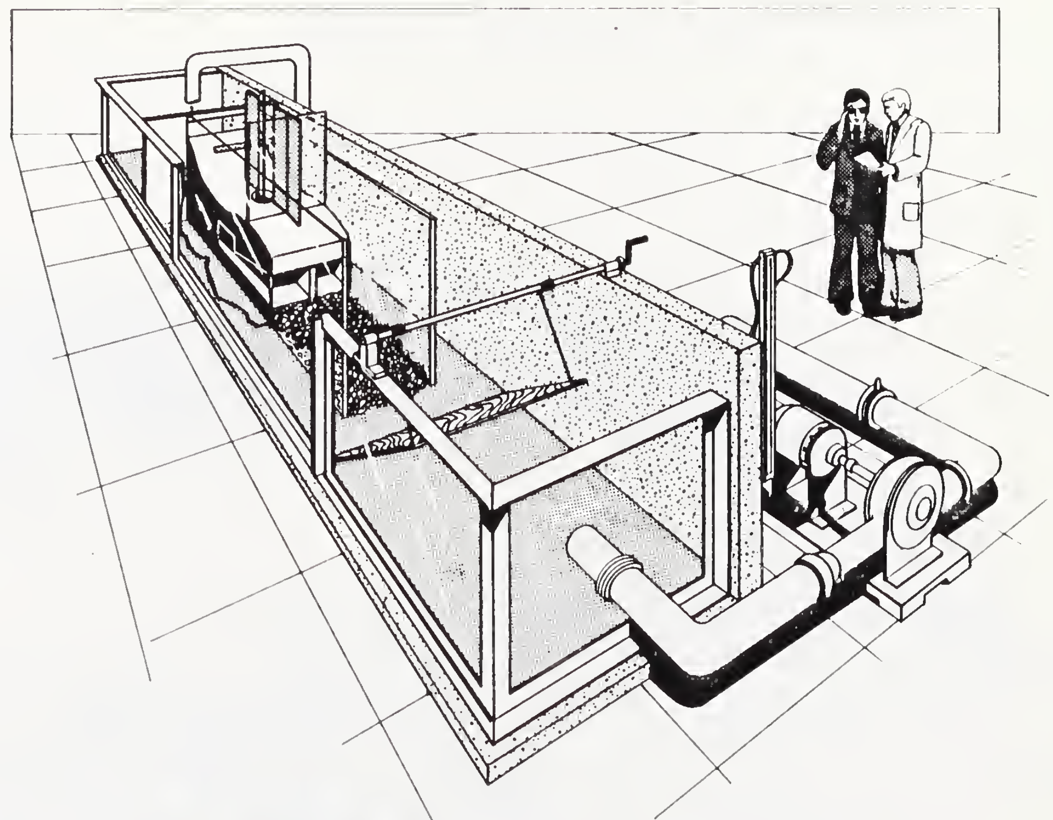


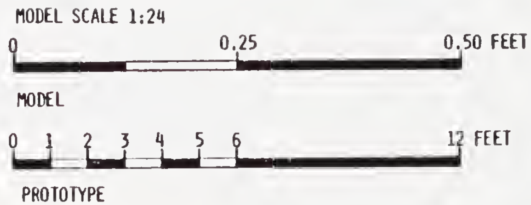
PLATE 1

PROJECT LOCATION AND EXTENT OF MODEL



MODEL LAYOUT
PLAN VIEW





ARTIST'S CONCEPT
NOT TO SCALE

PLATE 2

MODEL LAYOUT

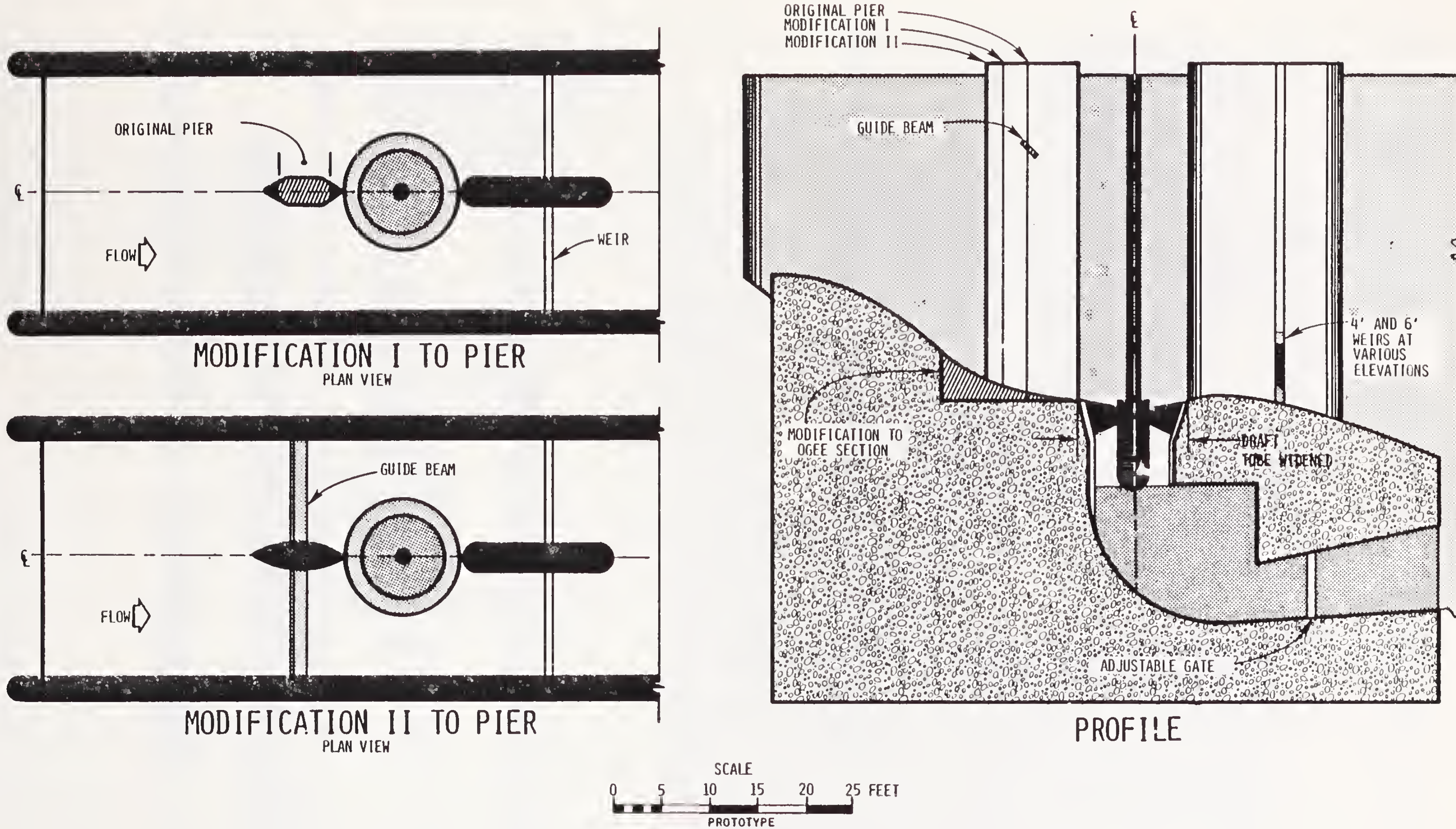


PLATE 3

EXPERIMENTAL MODIFICATIONS

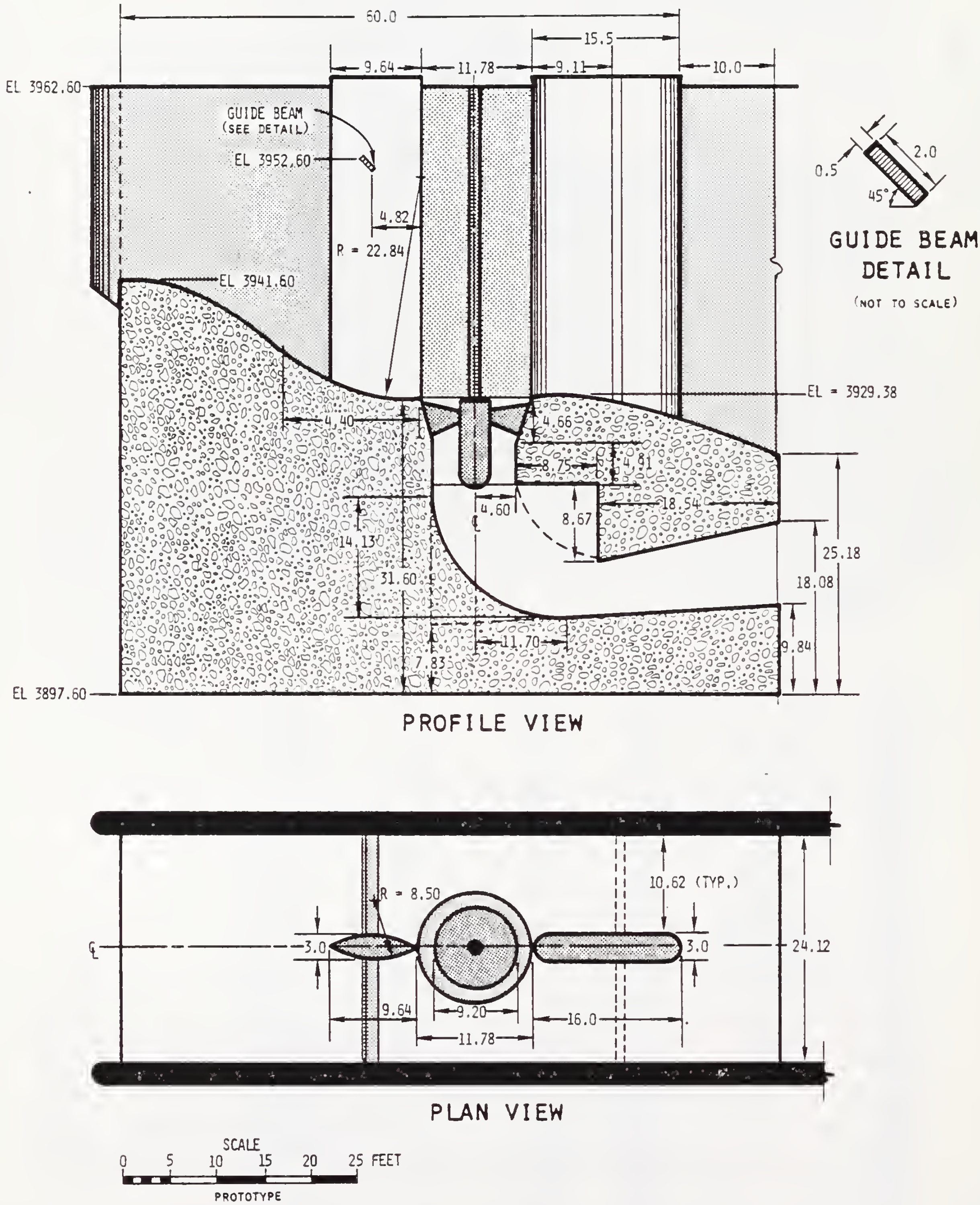


PLATE 4

DIMENSIONS OF FINAL
RECOMMENDED DESIGN

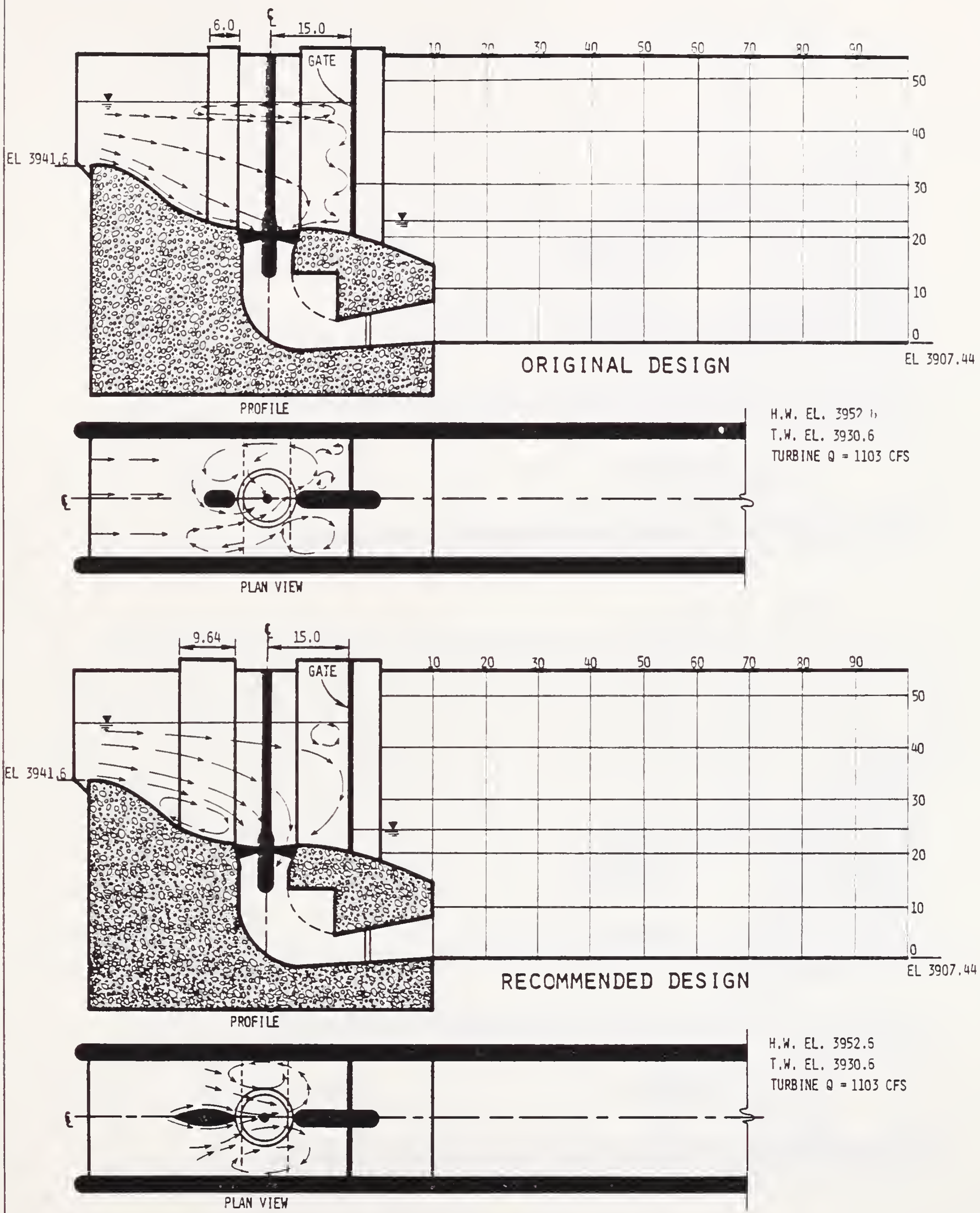
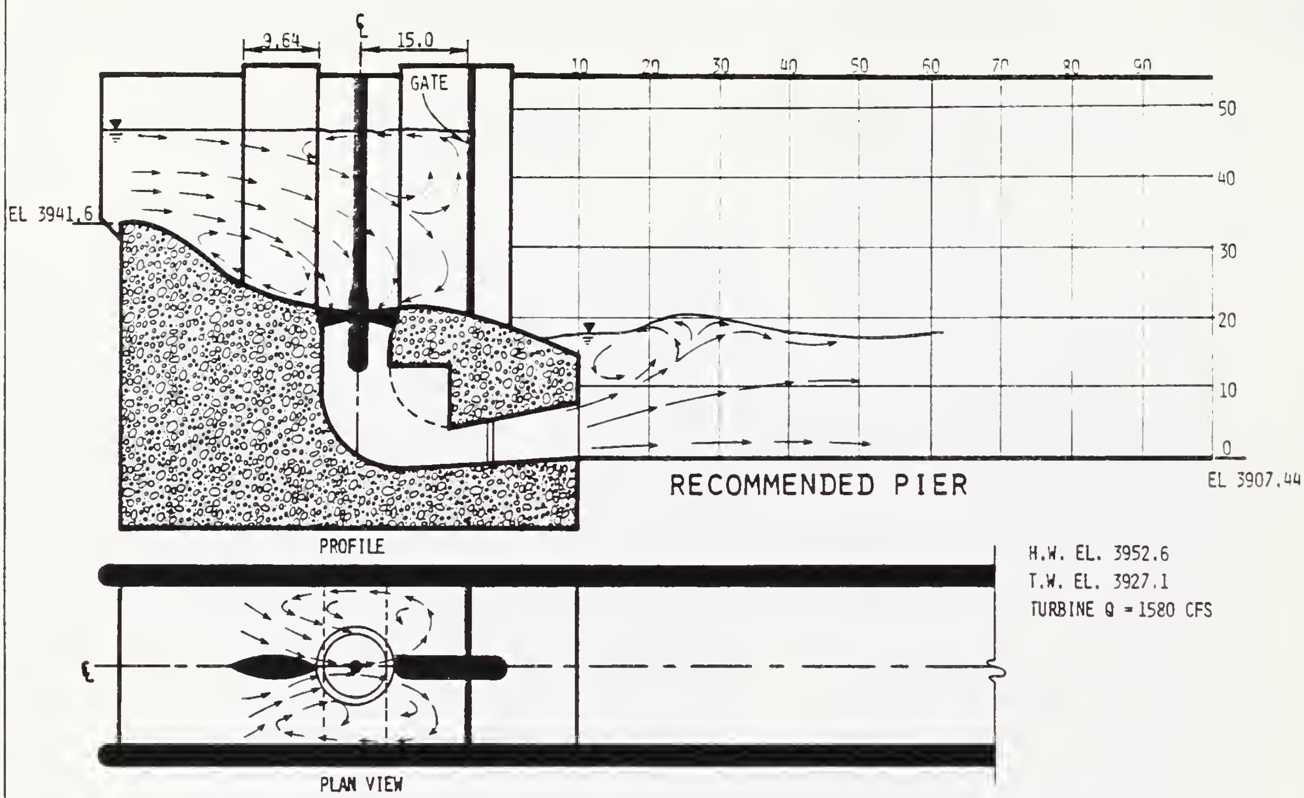
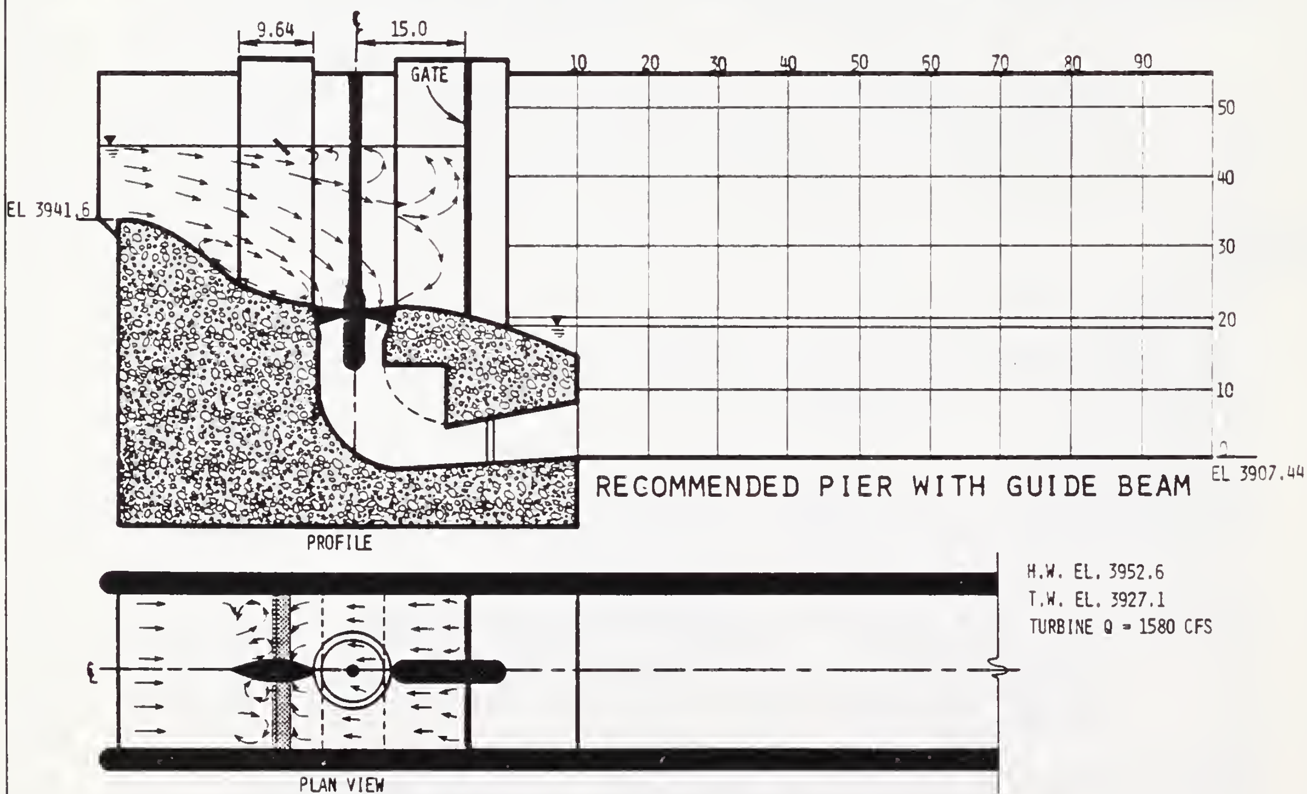


PLATE 5

FLOW PATTERNS FOR PIER TESTS



RECOMMENDED PIER



RECOMMENDED PIER WITH GUIDE BEAM

FLOW PATTERNS FOR
GUIDE BEAM TESTS
Q = 1580 CFS

PLATE 6

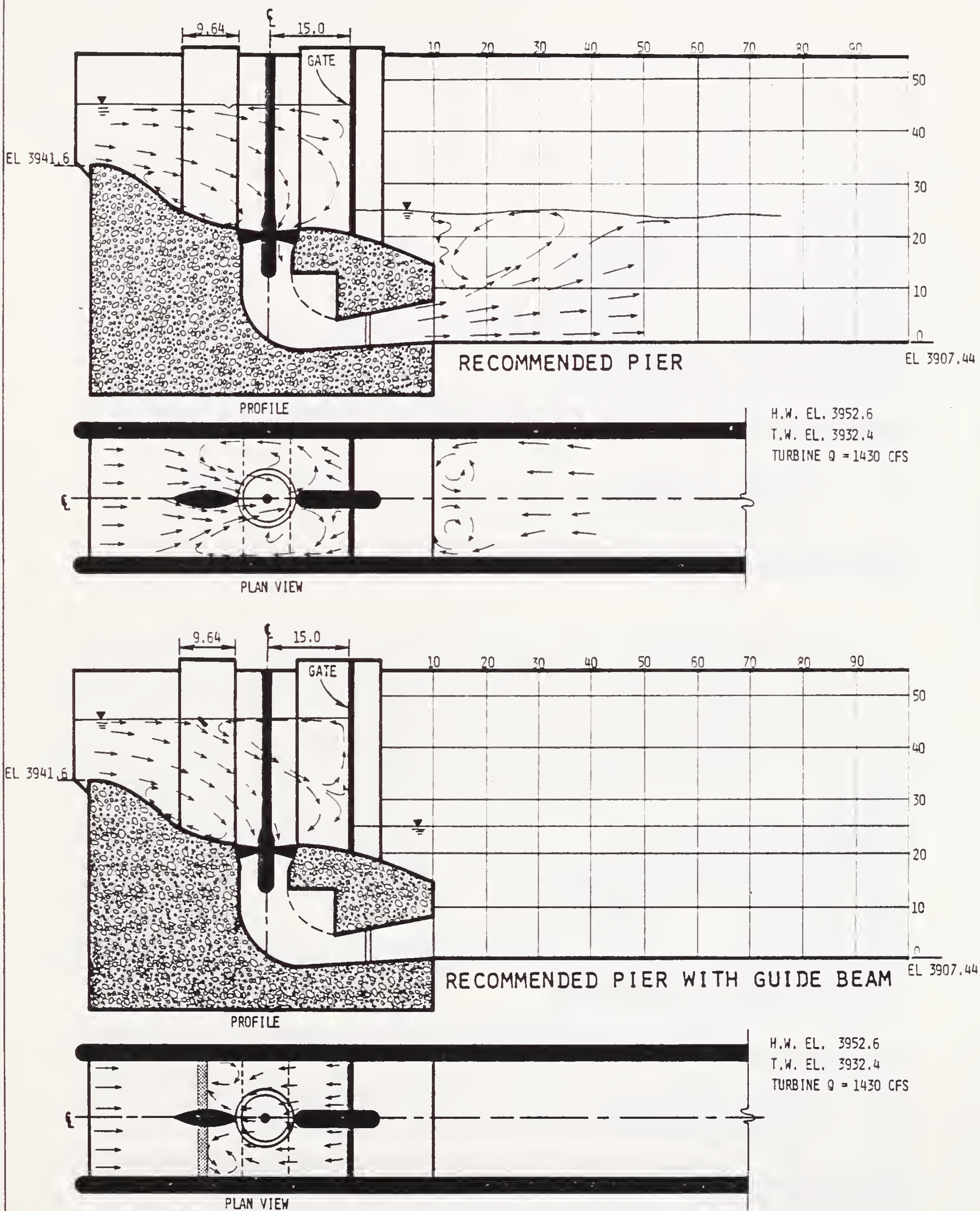
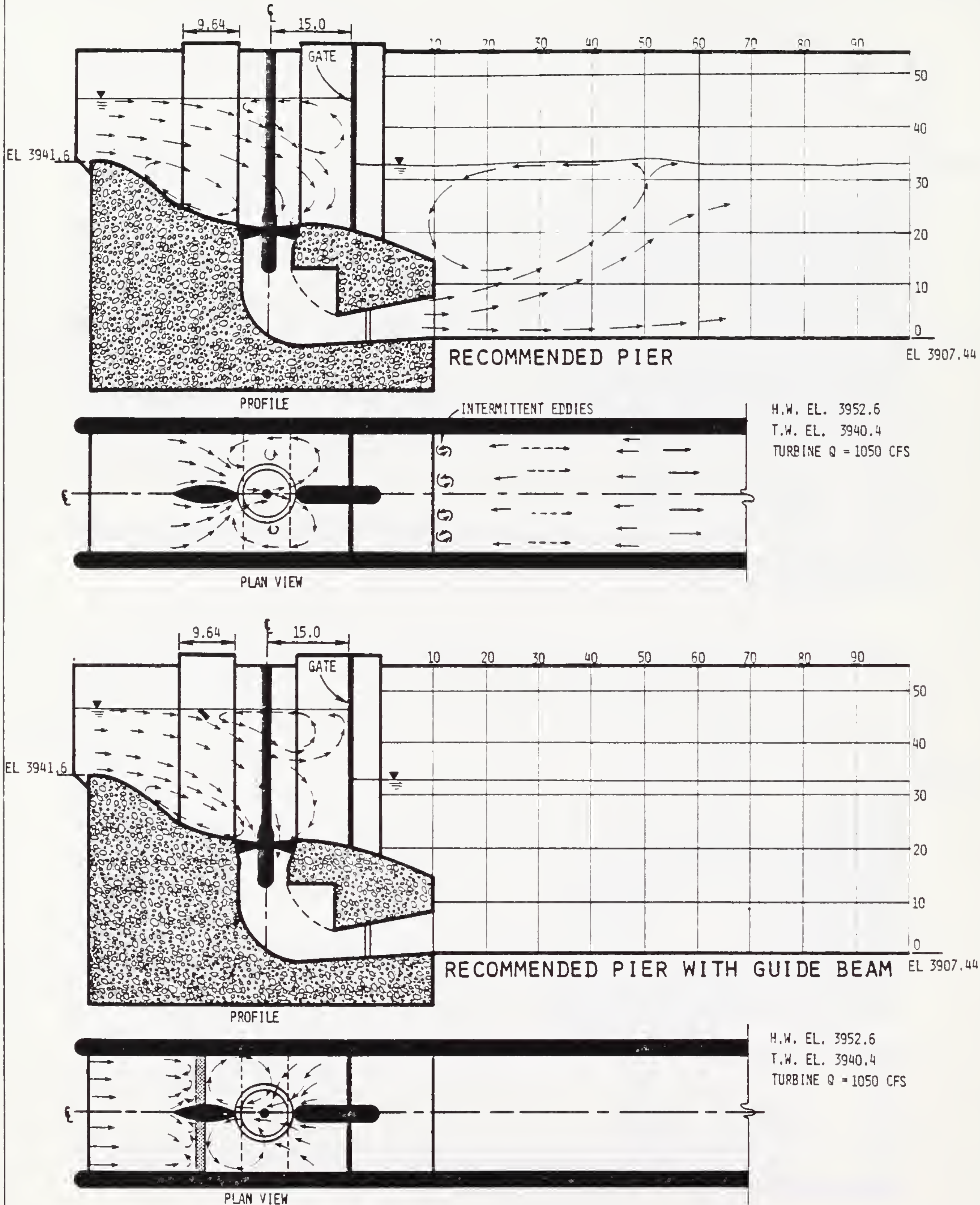


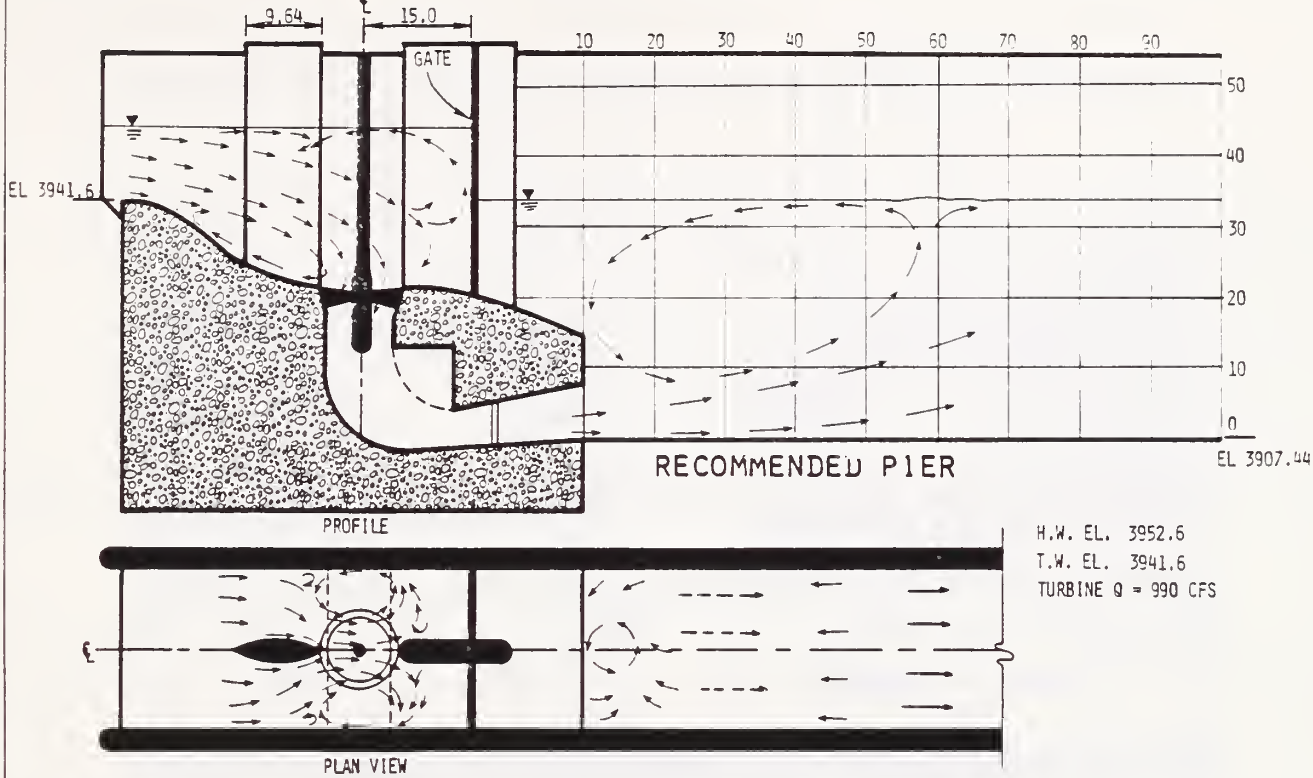
PLATE 7

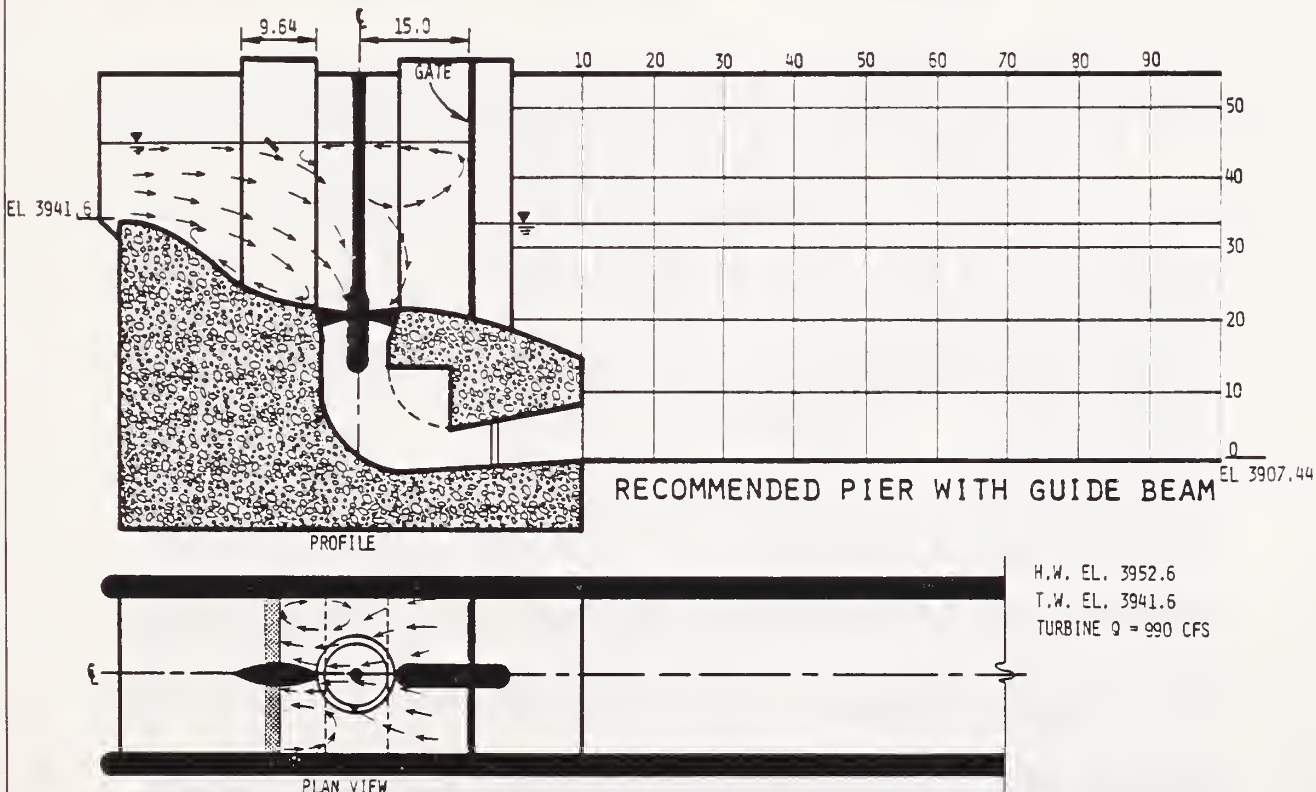
FLOW PATTERNS FOR
GUIDE BEAM TESTS
Q = 1430 CFS



FLOW PATTERNS FOR
GUIDE BEAM TESTS
Q = 1050 CFS

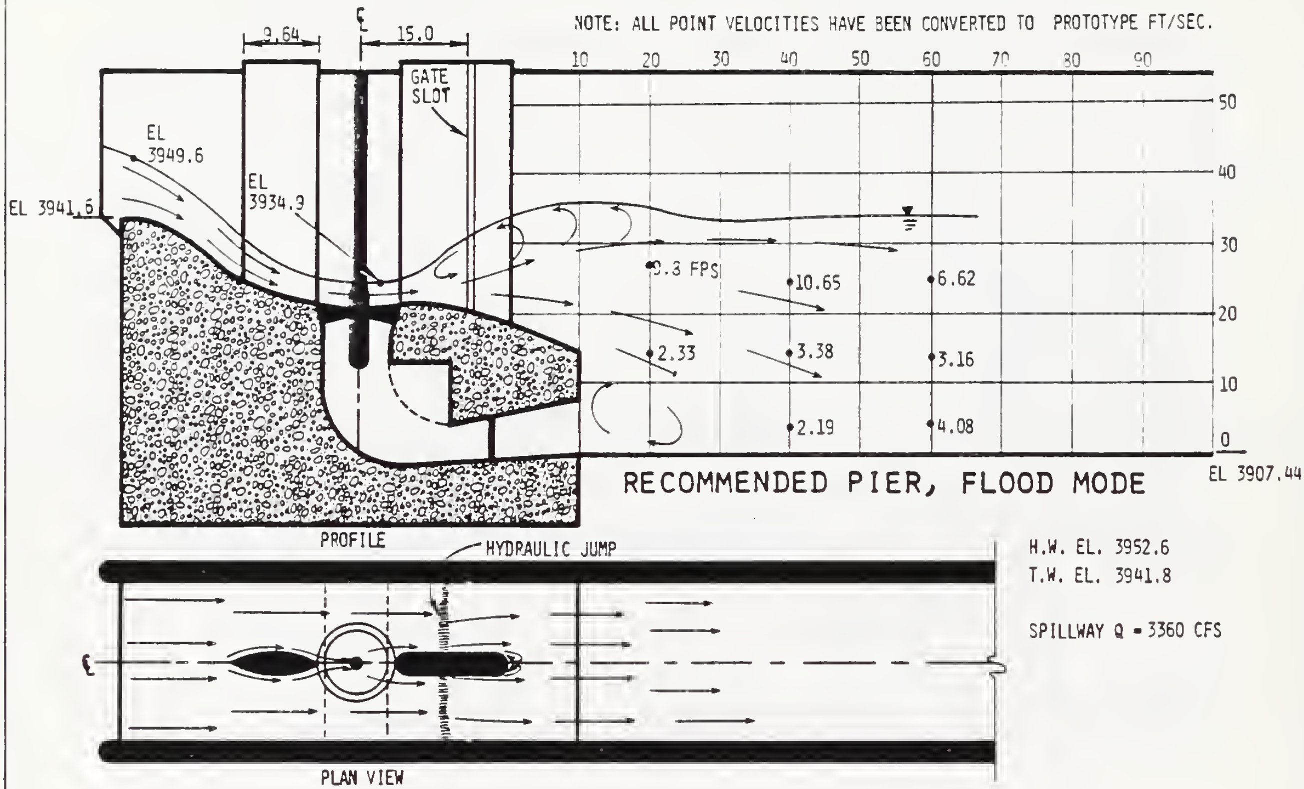
PLATE 8





FLOW PATTERNS FOR
GUIDE BEAM TESTS
Q = 990 CFS

PLATE 9



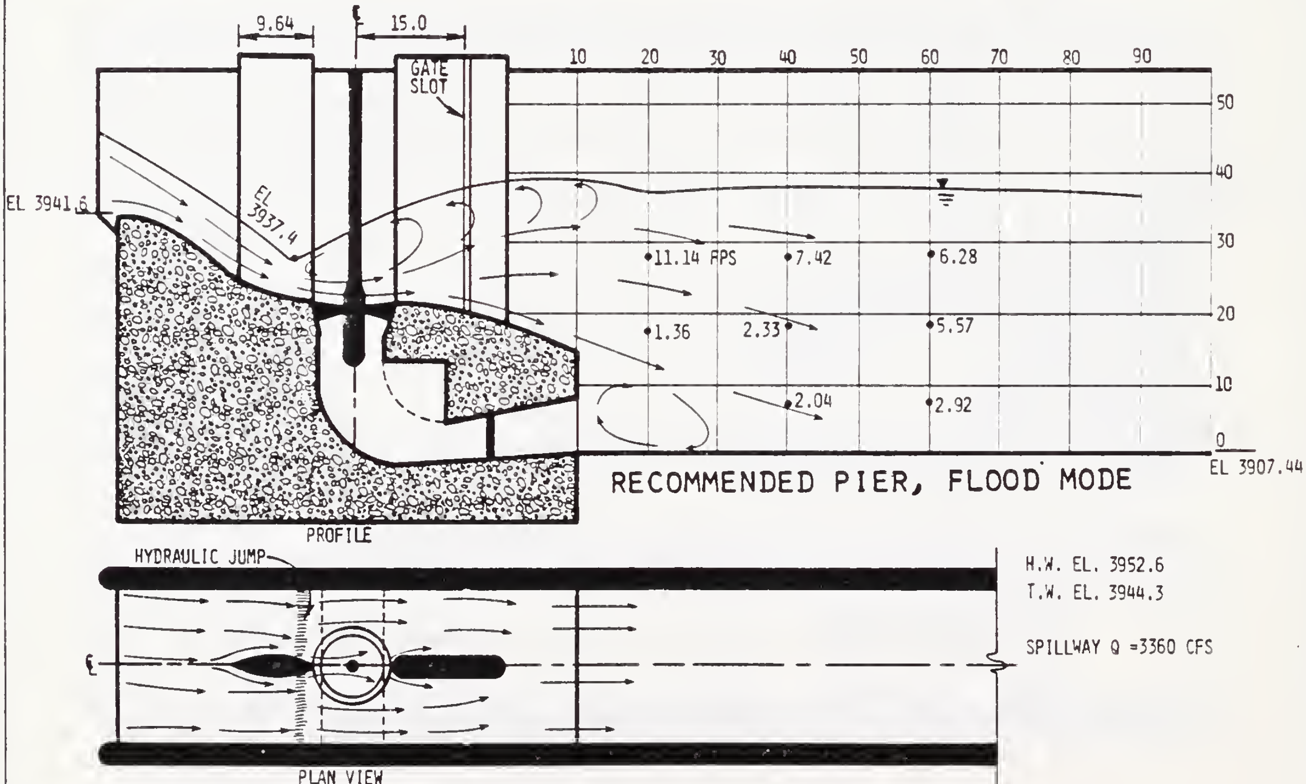
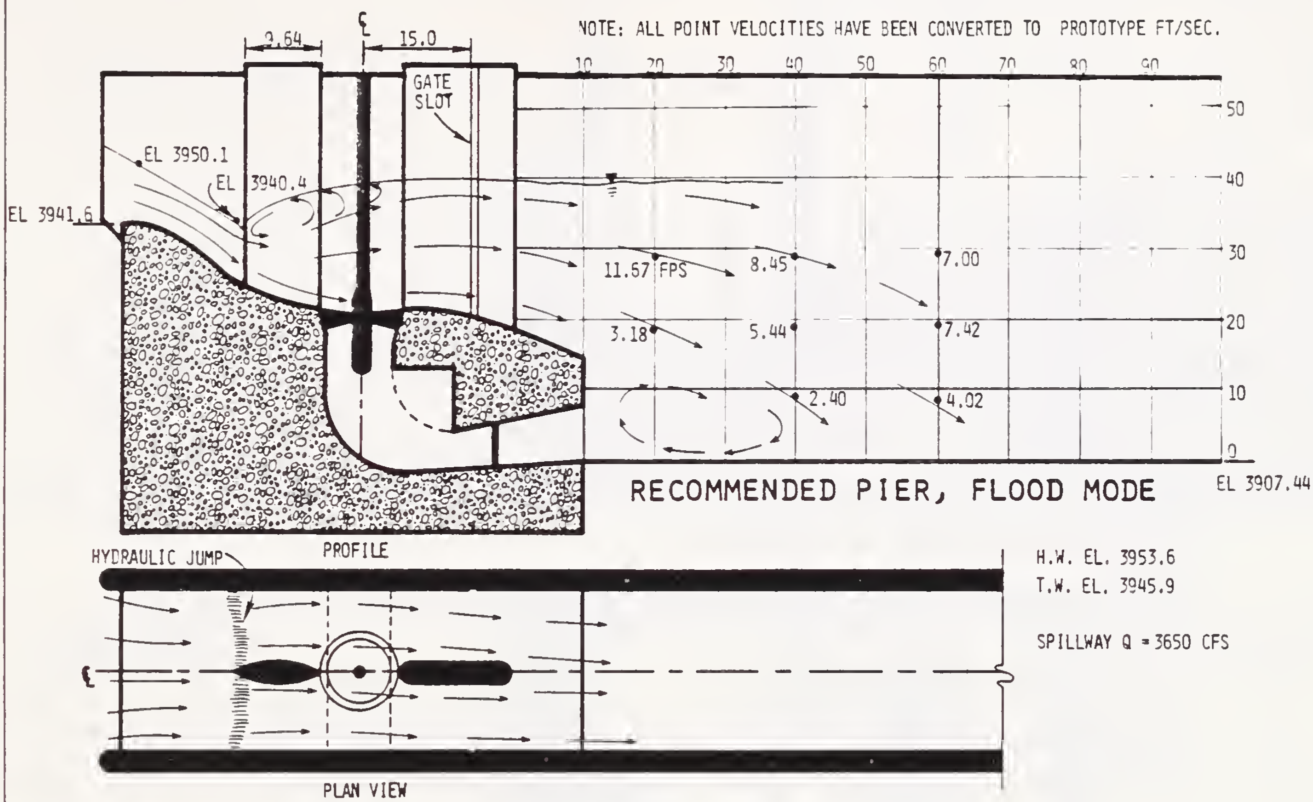


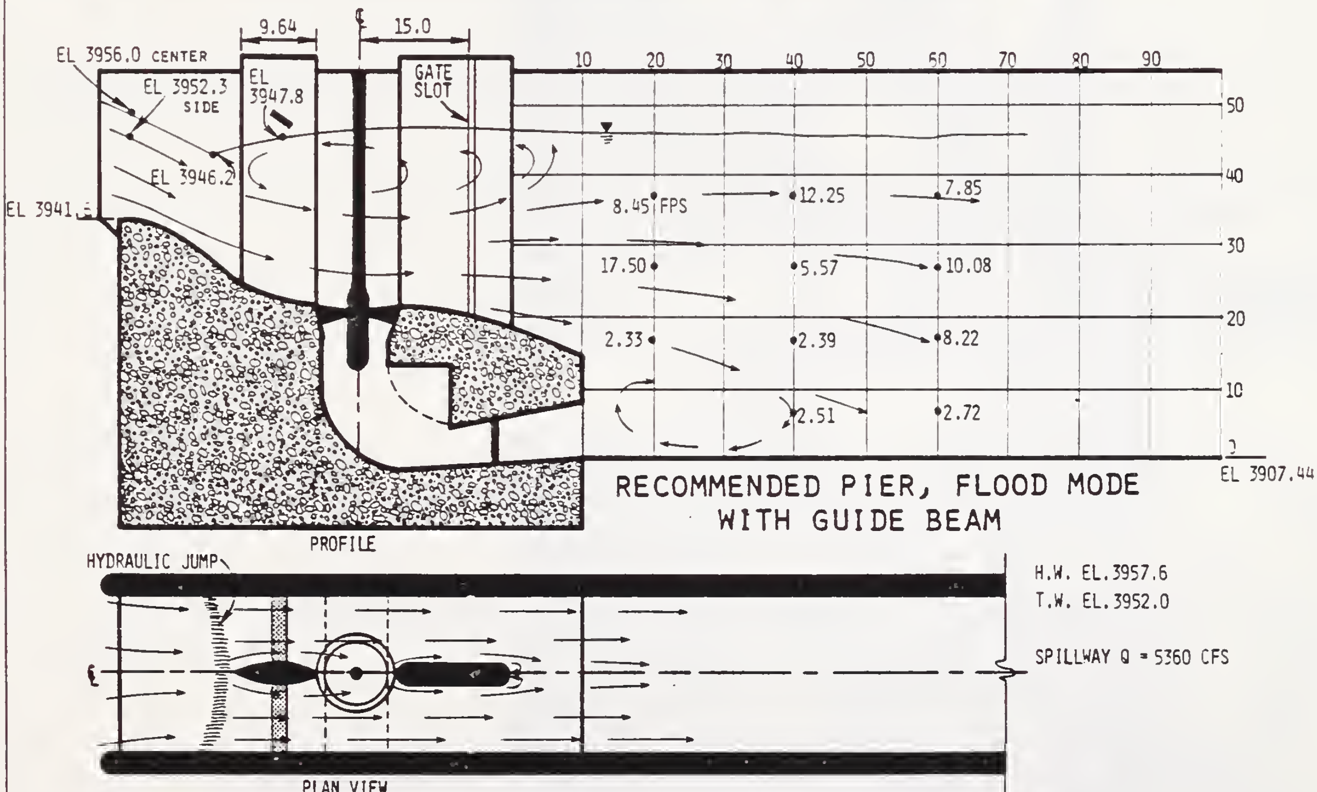
PLATE 10

FLOW PATTERNS FOR FLOOD MODE

NOTE: ALL POINT VELOCITIES HAVE BEEN CONVERTED TO PROTOTYPE FT/SEC.



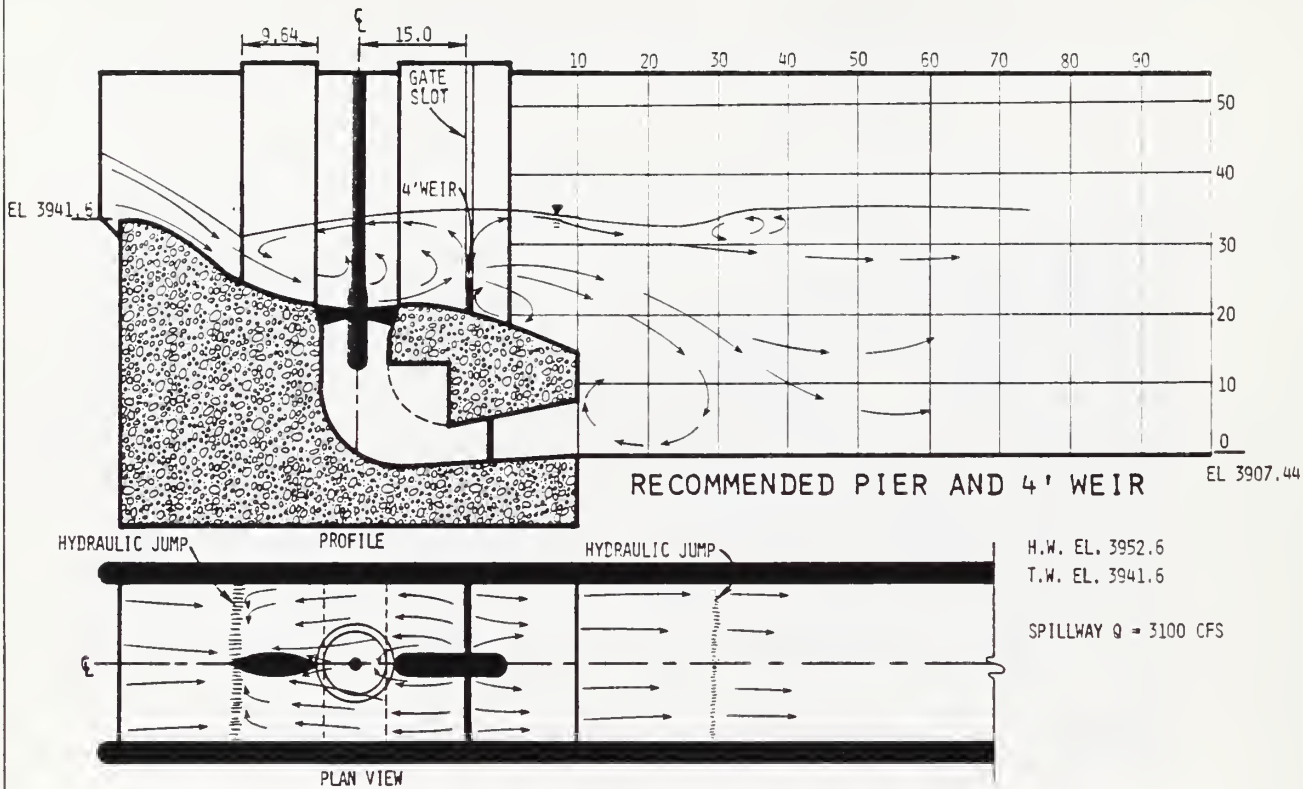
RECOMMENDED PIER, FLOOD MODE



RECOMMENDED PIER, FLOOD MODE
WITH GUIDE BEAM

PLATE 11

FLOW PATTERNS FOR FLOOD MODE



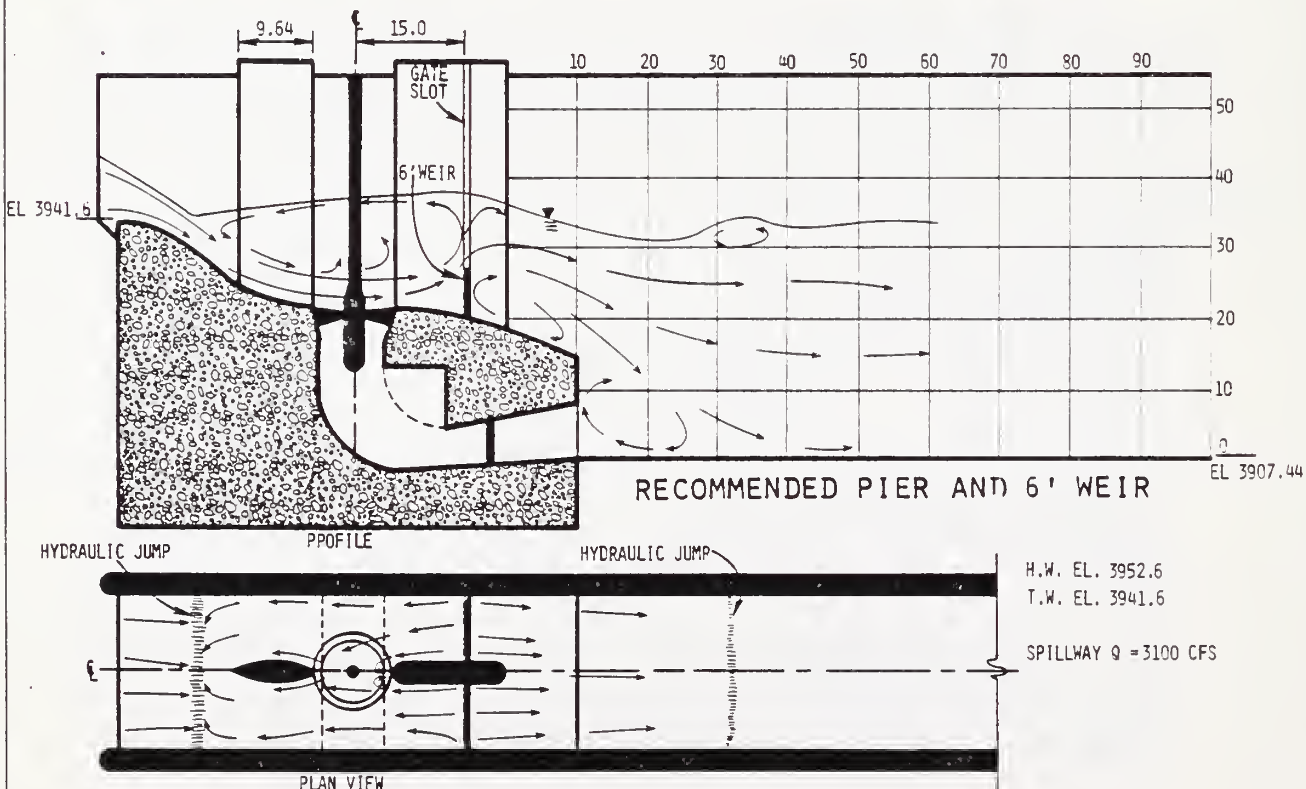
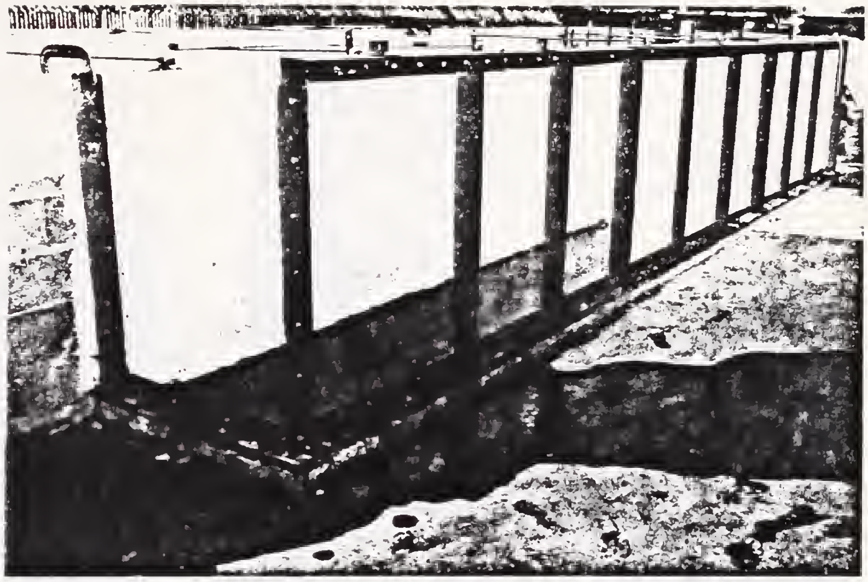


PLATE 12

FLOW PATTERNS FOR ENERGY DISSIPATOR TESTS

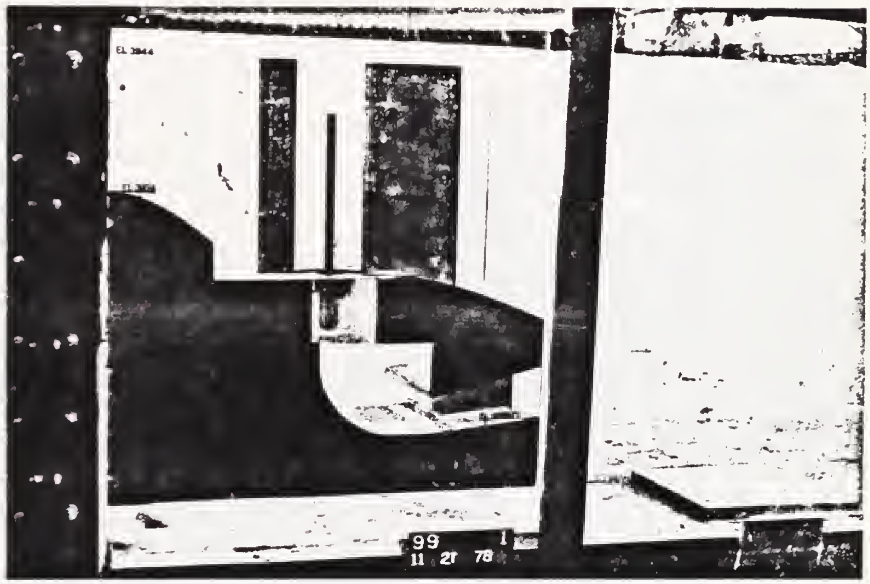
Photograph 1

Construction of the two-dimensional flume which housed the Broadwater Dam model.



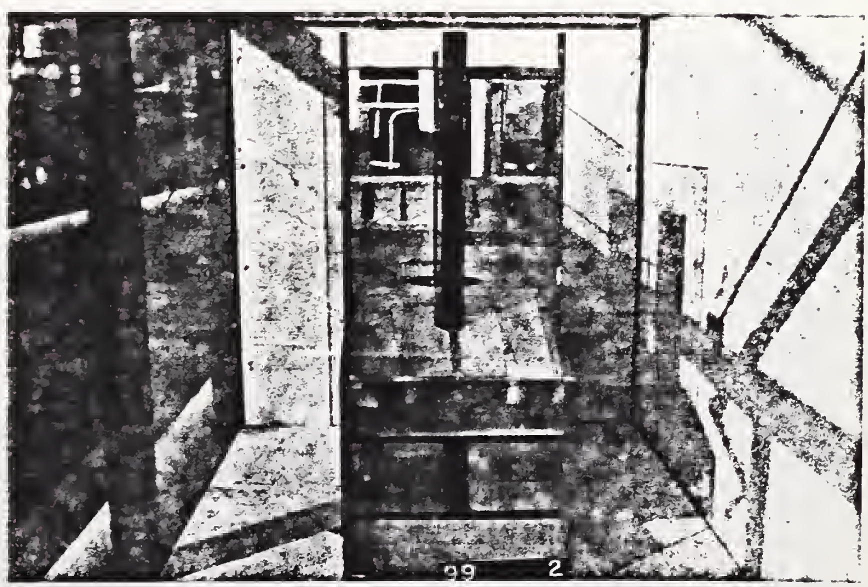
Photograph 2

Acrylic plastic model of the ogee section and turbine draft tube in the overflow spillway of the Broadwater Dam.



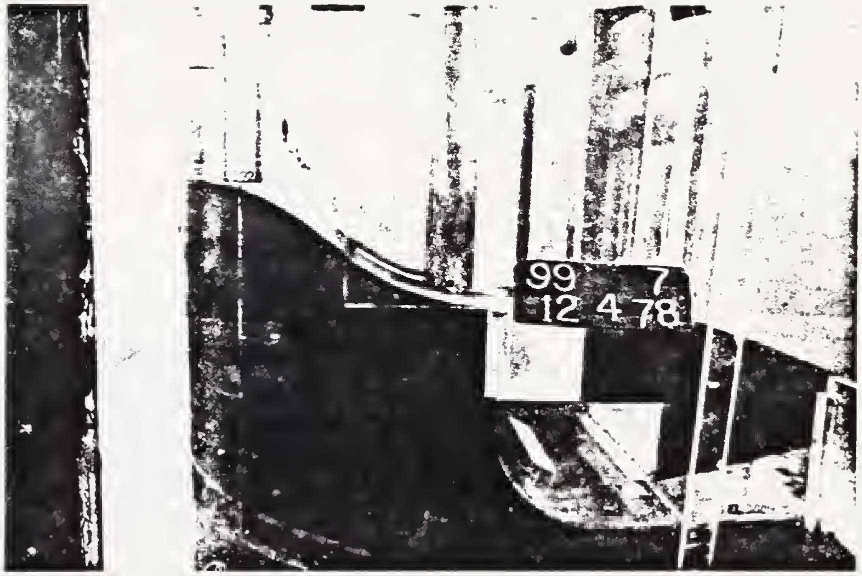
Photograph 3

View of the model showing draft tube exits and pier placement.



Photograph 4

Side view of model structure showing modified section from the ogee section to the entrance of draft tube.

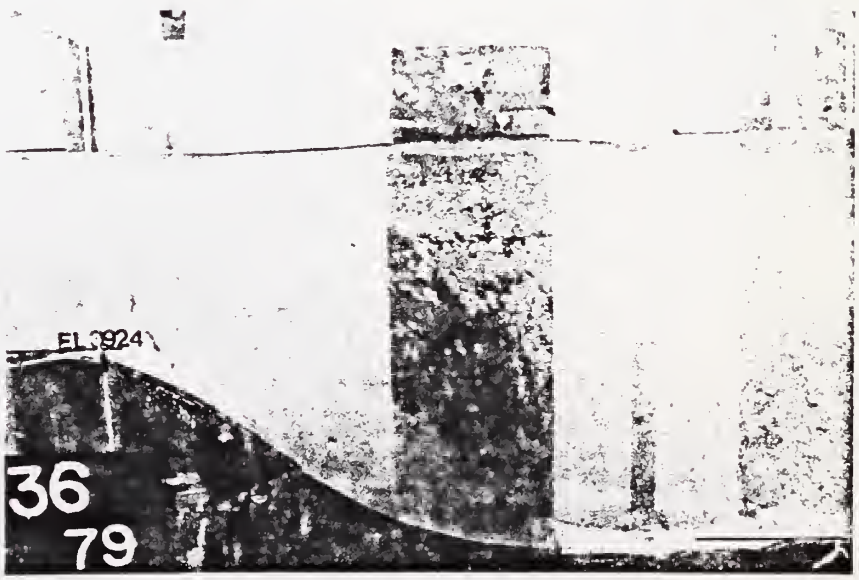


Photograph 5

Scour pit immediately downstream of the draft tube exit created during flood mode, Q = 3060 cfs, low T.W. 3930.6 ft.

Photograph 6

Generation mode condition, Q = 1480 cfs, T.W. 3931.0 ft. No beams in place, but note depression in water surface downstream of pier.

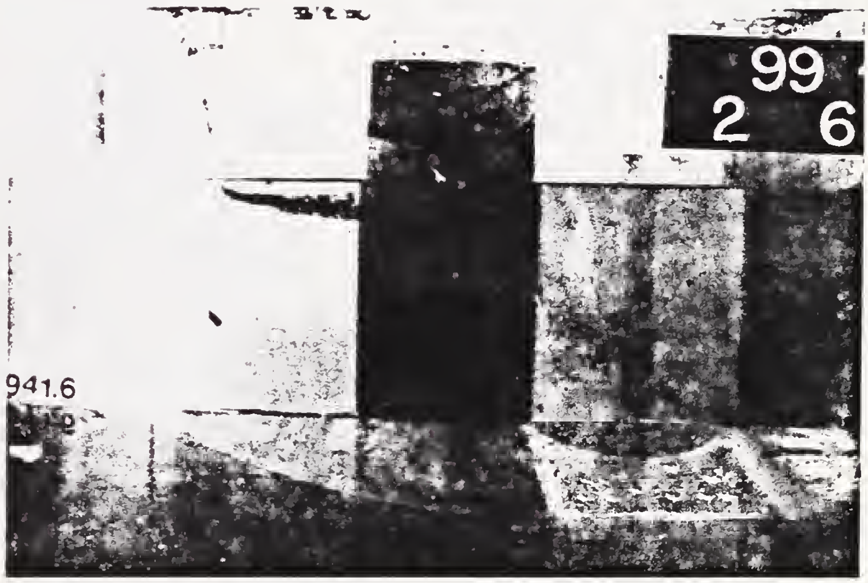


Photograph 7

Generation mode condition, Q = 1580 cfs, T.W. 3927.1 ft. Guide beams in place with satisfactory hydraulic performance.

Photograph 8

Generation mode condition, Q = 990 cfs, T.W. 3941.6 ft. Guide beam in place with satisfactory flow conditions.

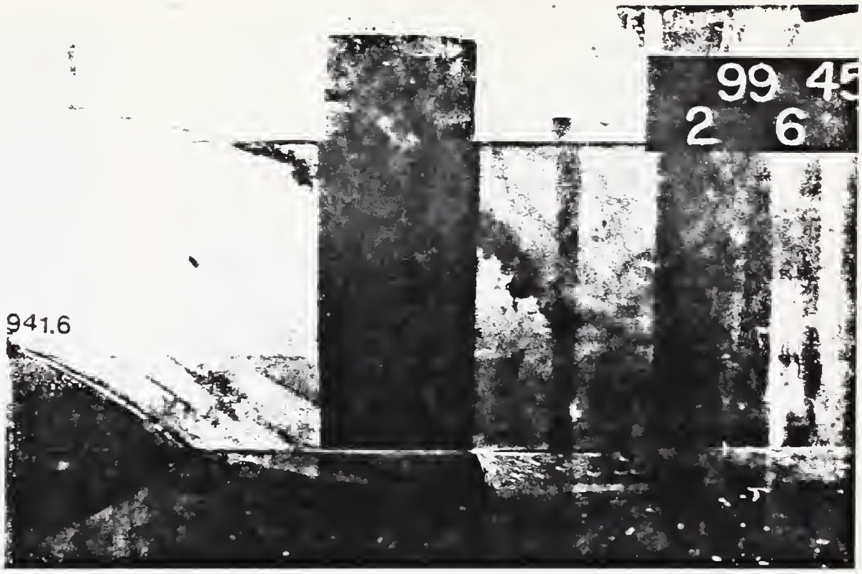


Photograph 9

Generation mode condition, Q = 1250 cfs. T.W. 3936.4 ft. Guide beams not in place and satisfactory flow condition.

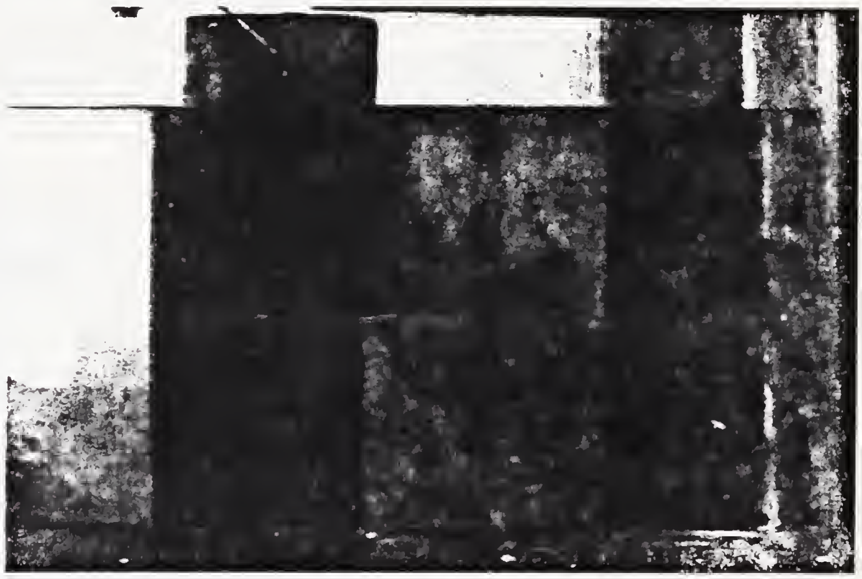
Photograph 10

Generation Mode Condition, Q = 1250 cfs. T.W. 3936.4 ft. with guide beams in place and satisfactory flow conditions.



Photograph 11

Generation mode, Q = 1250 cfs T.W. 3936.4 ft. with guide beams and dye injection from behind the beam.

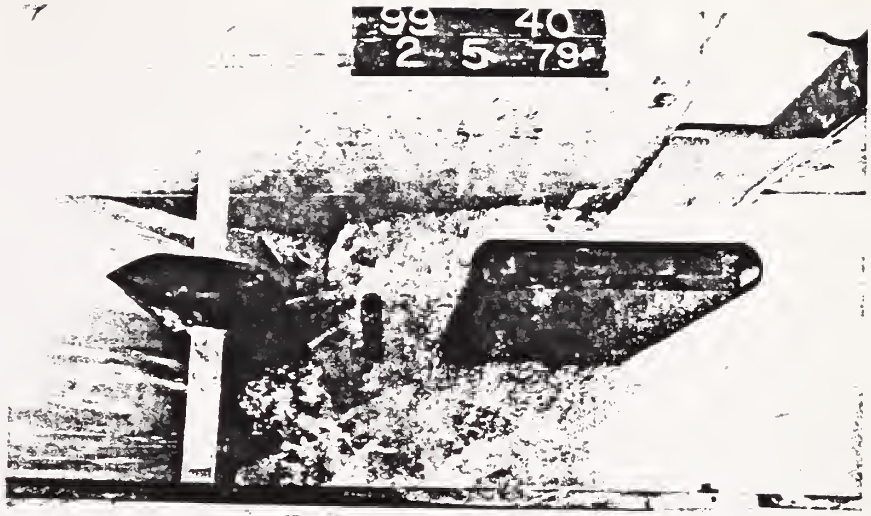


Photograph 12

Controlled flood mode condition, Q = 3060 cfs, T.W. 3941.8 ft. Top view of the flow condition in the power bay. Strong hydraulic jump occurred in the bay. The clearance between water surface and guide beams is approximately 22.0 ft.

Photograph 13

Controlled flood mode condition, Q = 3060 cfs T.W. 3944.3 ft. Hydraulic jump in the power bay, which is semi-submerged. Compare the flow condition to that of photograph 12. The clearance between water surface and guide beams is approximately 14.0 ft.



Photograph 14

Uncontrolled flood mode condition, Q = 3650 cfs, T.W. 3945.9 ft. Flow condition in the power bay.

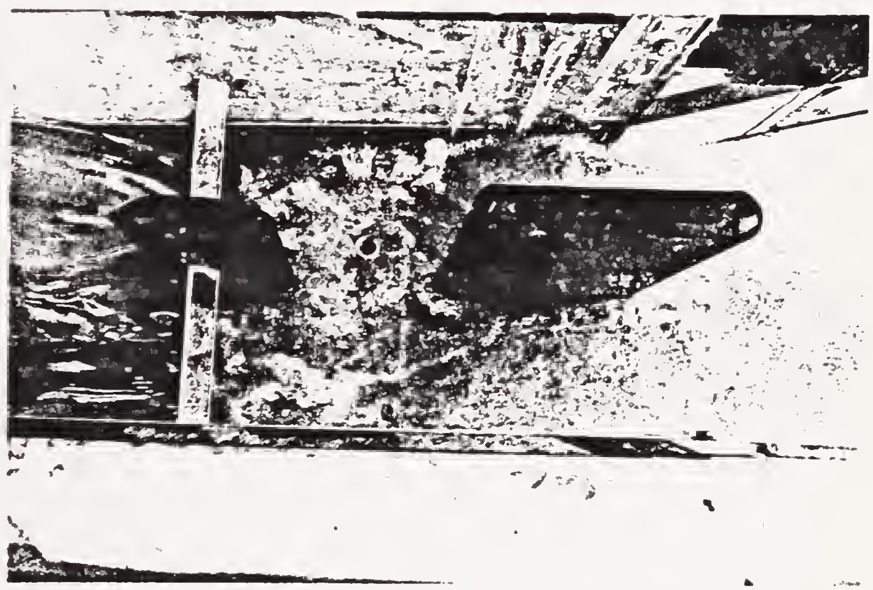


EXHIBIT B

PROJECT OPERATION AND RESOURCE UTILIZATION

EXHIBIT B

PROJECT OPERATION AND RESOURCE UTILIZATION

B.1 PROPOSED PROJECT OPERATION

B.1.1. General

The installation of the proposed hydroelectric facilities at Broadwater Dam would slightly alter the reservoir operation. Historically, the reservoir water surface elevation was allowed to fluctuate seasonally. The reservoir level was maintained at a higher level during the irrigation season when the flashboards were installed. During the winter and early spring, when the flashboards were not in place in the dam, the reservoir level was controlled by the dam crest. To facilitate power production, the Applicant proposes that the normal reservoir level be maintained at a more constant elevation of about 3952.6 feet, MSL. The environmental impacts of this change are discussed in Exhibit E. Neither the amount of downstream and irrigation releases nor the timing of the releases would be changed.

B.1.2 Method of Plant Operation

The control scheme for the Broadwater Power Project would be based on the concept that normal operation would be semi-automatic. Equipment for complete remote monitoring of flow, water surface elevations, unit status and generation output, and a remote unit stop capability are included in this project's layout and estimates. No remote start capability is included. Because of the distance of the Broadwater site from a population center, however, occasional on-site operation would be desirable for safety reasons. It is assumed that the plant would be staffed eight hours per day, five days per

week. Staff facilities, including working space and comfort facilities, would be included. Also, it is assumed that the facility would be continually attended during periods of probable flooding in order to operate the radial gates and convert the turbine bays to spillway bays as required.

B.1.3 Method of Reservoir Operation

There are four different operation modes that may be utilized at the Broadwater Power Project. A description of each follows:

1. Pure Generation Mode

   In the pure generation mode, the entire release past the dam would be through the turbines. The range of flows would be from 515 cfs (the lower limit of one turbine assuming no irrigation) to 5,920 cfs. The turbine flow would be regulated so as to maintain a constant upstream water surface elevation of 3952.6 feet.

2. Combined Operation Mode

   In the combined operation mode, the required outflow would be greater than could be passed through the turbines. Therefore, the radial gates would be opened to pass the additional flow in as many spillway bays as necessary. The range of flows would be between 5,920 cfs and 32,408 cfs, the turbines would remain in operation and, as in the pure operation mode, the headwater surface elevation would still be held constant at 3952.6 feet.

3. Controlled Flood Mode

   In the controlled flood mode, the required outflow would be larger than could be passed through the turbines

with all of the spillway bays fully open. Therefore, the number of turbine bays as required to hold the normal upstream water surface at elevation 3952.6 feet would be converted to spillway bays. The range of flow would be between 32,408 cfs and 43,782 cfs. Turbine operation would not be possible in those bays converted to spillway bays, due to the turbulent conditions within the bay.

The following sequence of events would be involved in converting a turbine bay to a spillway bay:

a. The turbine would be stopped.
b. The radial gate would be lowered.
c. The trashrack would be removed.
d. The fixed wheel gates comprising the rear of the power bay would be removed.
e. A section of the removed fixed wheel gate would be placed in the downstream stop-log slot to prevent further flows from passing through the draft tube.
f. The radial gate would be raised and flows would then pass unhindered through the plant.

This entire procedure of converting a turbine bay into a spillway bay is expected to be accomplished in one hour or less.

It should be noted that the necessary conversion of one or more turbine bays to spillway bays would occur very infrequently. The hydrology analyses show that, in conjunction with the regular spillway bays functioning, only one power bay would be necessary to pass a 20-year flood; two bays for a 33-year flood, three bays for 50-year flood; and all four bays for greater floods.

4. Uncontrolled Flood Mode

In the uncontrolled flood mode, all of the turbine bays would be converted to spillway bays and no turbine operation would be possible. No further control on the upstream water surface elevation would be possible. A flow of 76,200 cfs, with a recurrence interval of 10,000 years, could be passed before the existing abutments would be overtopped.

B.1.4 Proposed Reservoir Operation

As mentioned in Section A.1.2, the impoundment formed by Broadwater Dam has a gross pool capacity of 6,460 acre-feet. An area-capacity curve for the reservoir is included as Exhibit B-1.

At the present time there is no rule curve for the operation of the reservoir and active storage is not used or planned to be used for power development. The dam is operated on a day-to-day basis during the summer irrigation season depending on the level of the river and the needs of the region's irrigators. (See Section A.1.4, for a discussion of the historical operation of Broadwater Dam.) Since operation of the dam is unlikely to change in principle due to the power plant, there would be no rule curve to govern reservoir operation. Essentially the dam would be operated in such a manner as to maintain a constant upstream elevation of 3952.6 feet. It should be expected, however, that there would be some fluctuation from the target level due to operational limitations. Every effort would be made to keep such fluctuations small.

Water rights in Montana are based on the appropriation doctrine. Water rights with priority dates earlier than 1973 are based on historical water use. The Applicant filed an

application for water permit on December 30, 1977. During periods of low streamflow, the water demands of prior appropriators will be met first. Appropriations by downstream users will be used for power generation, while appropriations by upstream users will deplete streamflows available for power generation. No power will be generated when the outflow from the reservoir drops below 515 cfs, the lower limit of one turbine. It should be noted that streamflows below 515 cfs have less than one percent probability of occurrence. The project hydrology is discussed in the next section. All of the above considerations are reflected by the stream flow records utilized in the operation study for the project.

The operation study does not reflect undeveloped rights claimed by the Bureau of Reclamation (BOR) at Canyon Ferry Dam. The Bureau of Reclamation built Canyon Ferry Dam in 1953 to permit further irrigation development in the Upper Missouri River basin. By creating the large Canyon Ferry Reservoir, the BOR could guarantee that existing downstream water rights could be met despite increased depletion of river water for agricultural use. The original authorization anticipated downstream depletions and upstream water exchange to meet agricultural needs, and a 400,000 acre-foot block of storage in the reservoir was reserved for this purpose. Current development has used approximately 100,000 acre-feet of this stored water. Although attempts have been made to quantify BOR's legal rights to Canyon ferry water, a final determination has never been reached. A final determination will be handed down by the courts at sometime in the future.

Nonetheless, the remaining 300,000 acre-feet could potentially be developed upstream of Broadwater Dam, and an operation study was conducted to determine if the additional depletion would adversely affect energy generation at the site. The results showed only minor effects on operation--the selection between three or four turbines for the optimum design

was only marginally different when their respective benefit/cost ratios were evaluated. Thus, the Applicant decided to proceed with the four-turbine unit.

B.2 POWER AND ENERGY

B.2.1 Hydrology

The U.S. Geological Survey stream gage, "Missouri River at Toston" (No. 06054500) is located on the Missouri River approximately three miles downstream of Broadwater Dam. The difference in drainage area between the gage and the dam is negligible, especially considering the large total drainage area. Therefore, the Toston record was considered to be a reasonable record of the flow over Broadwater Dam and was used in the project operation studies without modification.

The Toston stream gage record has been in continual operation since April, 1941. One of the worst series of drought years in Montana history occurred during the 1930's, which was not included in these records. This drought period is normally used to determine the dependable capacity of hydroelectric plants within the state; therefore, it was necessary to extend the Toston record to cover this critical drought period.

The extension was accomplished using a computer program developed by the Hydrologic Engineering Center (HEC), U.S. Army Corps of Engineers (the Corps), entitled "HEC-4, Monthly Streamflow Simulation". HEC-4 uses a normalized Pearson Type III Distribution in correlating the missing months of records with other known records in the region. Several stream-gage records, both upstream and downstream of the Toston gage, were evaluated for selection of the best extension of the Toston record.

It was decided to utilize two records, both on upstream tributaries to the Missouri River. One was the "Big Hole River near Melrose", Gage No. 06025500. The Big Hole River is a tributary to the Jefferson River. The drainage area above the Melrose gage is 2,476 square miles. The other gage was the "Gallatin River at Logan", Gage No. 06052500. The drainage area above the Logan gage is 1,795 square miles.

Using data from these two gages and the HEC-4 program, the Toston record was extended back to 1929. This extension, in conjunction with existing record, gives a 50-year record over the period 1929 to 1978. In general, the correlation coefficients for the extension were good, ranging from 0.7 to 0.9. The streamflow data derived for the 1930's was indicative of the known drought conditions and was found to be consistent with precipitation records for those years.

Minimum measured discharge during the 1941-1978 period was 562 cfs on April 30, 1941. The maximum measured discharge, 32,000 cfs, occurred on June 6, 1948. The mean discharge for the 1929-1978 period, which includes the synthetic data generated by the HEC-4 program, was 4,430 cfs. A flow-duration curve for the entire 50-year period is included in this application as Exhibit B-2.

B.2.2 Flood Hydrology

The design flood for Broadwater Dam is considered to be that flood which could pass over the dam without overtopping the retaining wall sections at the dam abutments. The dam was originally designed to pass a flood of 50,000 cfs with a recurrence interval of 250 years. During recent investigations of the site, however, calculations revealed that the actual design flood for the dam was much higher. The dam will pass a flow of 76,200 cfs that is expected to occur once in 10,000 years. This is approximately half the magnitude of the

probable maximum flood at the dam, which is estimated to be 143,000 cfs.

The size of the design flood was calculated assuming a maximum permissible reservoir surface elevation of 3957.6 feet, equal to the top elevation of the dam abutments. This analysis recognizes the constricting effect of the new piers to be constructed across the spillway. The structural additions included in the turbine bays would not affect the flood-flow capacity, as they would be located downstream of the control section of the ogee crest.

If a flood greater than the design flood were to occur at the dam, the structure would act as a submerged weir with the difference between the headwater and tailwater elevations declining to less than 6.0 feet. Should the dam actually fail during a flood greater than or equal to the design flood, the result would be a small surge that would quickly dissipate downstream from the dam site. In fact, as the magnitude of the flood increases, the elevation difference between headwater and tailwater decreases, and consequently the size of the surge also decreases. It is therefore reasonable to conclude that the dam presents no imminent danger to life or property at the few small dwellings on the riverbank downstream from the dam.

B.2.3 Tailwater Rating Curve

A tailwater-rating curve was developed to assess the potential project power production; for use in the hydraulic analysis of the downstream flow conditions; and to establish boundary conditions for the hydraulic model testing.

The stage-discharge data for the Missouri River nearest to the project site was the rating curve for the Toston gage, located approximately three miles downstream of the dam. To develop and tabulate the curve directly below Broadwater Dam,

it was necessary to compute the river flow profile between the gage and the dam for various discharges. The profiles were calculated by the standard step method using the Corps' computer program "HEC-2, Water Surface Profile". Surveyed river cross-sections, taken at approximately one-half-mile intervals, were used as input.

The resulting computer model of the river flow profile was calibrated using water surface elevations measured at the cross-section locations for the day of the survey. The discharge values ranged from 4,000 to 5,590 cfs for the survey period, November 6 to December 6, 1978, which encompasses the average discharge of approximately 4,430 cfs. The resulting tailwater-rating curve is presented in Exhibit B-3.

A tailwater gage has been installed at Broadwater Dam since the time this tailwater curve was developed to monitor the actual stage-discharge relationship below the dam. Results for the first several months indicate that the actual head was within 95 percent of that given by the synthetic curve. Thus, the computer results may be considered adequate over the range of flows, 1900 to 5500 cfs, recorded thus far at the gage. This range of flows encompasses the middle to high discharge rates for the four-turbine operation.

B.2.4 Power Plant Capability

Power plant capability is a function of head and plant capacity. This relationship is shown in Exhibit B-4. The curves shown were derived from a typical turbine performance curve for the tube-type turbine which will be used at the Broadwater Project. The hydraulic capacity of the turbines was discussed in Section A.3.1.

B.2.5 Dependable Capacity

Exhibit B-5 shows the relationship between normal load demand for the Northwest Power Pool and projected power production at the Broadwater power plant. Since the peak demand of 41 GW occurs during January, and the minimum generation during this month was 3.93 MW in January of 1936 and 1937, this amount is taken to represent dependable capacity.

It should be noted, however, that a projected minimum of 0.92 MW was generated during August, 1931 when the monthly demand is about 32.5 GW. Depending on system operation and maintenance schedules, this value could also be used to represent dependable capacity at the proposed plant.

B.2.6 Average Annual Energy

Based on the information described above, operation studies were performed for the 50-year period from 1929 to 1978, to determine the amount of energy that would have been produced if the proposed power plant had been in operation during that period. The results, detailed in Appendix B, show an average annual energy production of 56.44 GWh. The maximum annual energy production for the study period was 69.48 GWh in 1976, and the minimum was 40.46 GWh in 1937.

B.2.7 Plant Factor

The 50-year operation study for the apron-mounted configuration resulted in an estimate of 56.4 GWh average annual energy production. The maximum possible annual generation of the 10-MW plant is 87.6 GWh. Thus, the average annual plant factor for the study period is 64.4 percent. The maximum annual plant factor for the period was 79.3 percent in 1976, and the minumum was 46.2 percent in 1937.

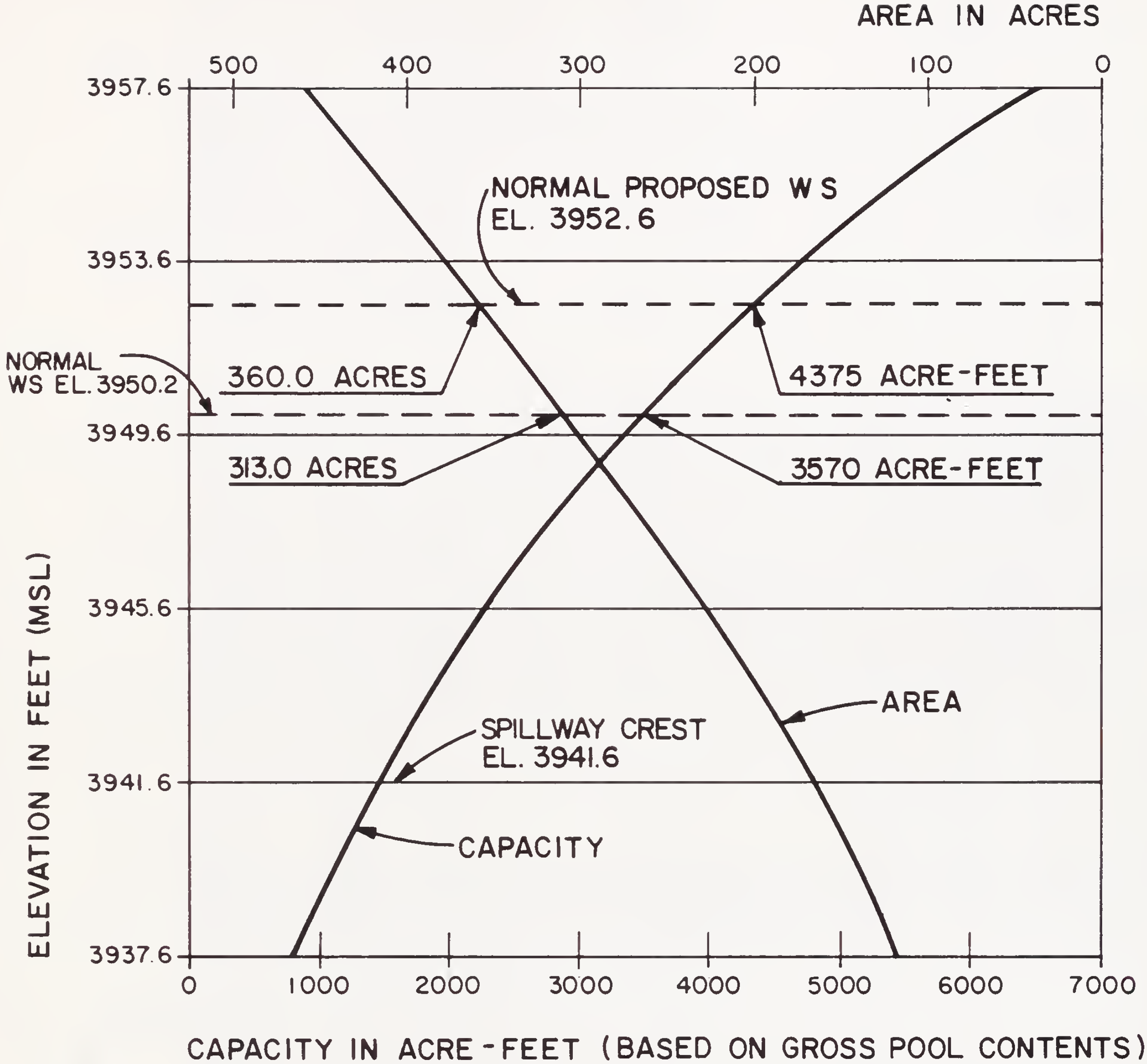
B.3 POWER UTILIZATION

The load curves, shown in Exhibit B-5, illustrate the general manner in which the power generated at the Broadwater Power Project would be utilized. Although a minor amount of power would be used at the site, the major portion of the power would be sold. The power purchaser is expected to be a Montana utility or electric cooperative.

B.4 FUTURE DEVELOPMENT

At the present time, the Applicant has no plans to increase capacity for power production at Broadwater Dam. However, if it proves to be economical at a later date, the Applicant may install additional turbine bays at the Broadwater site, bringing the total number of turbines to a maximum of six. Additionally, the Applicant may install a fish ladder at the site depending on the outcome of studies to be undertaken by the Montana Department of Fish, Wildlife and Parks. The new facilities will be designed with provisions to incorporate a fish ladder in the event that Fish, Wildlife and Parks requires one at a later date. The subject is discussed in more detail in Exhibit E.

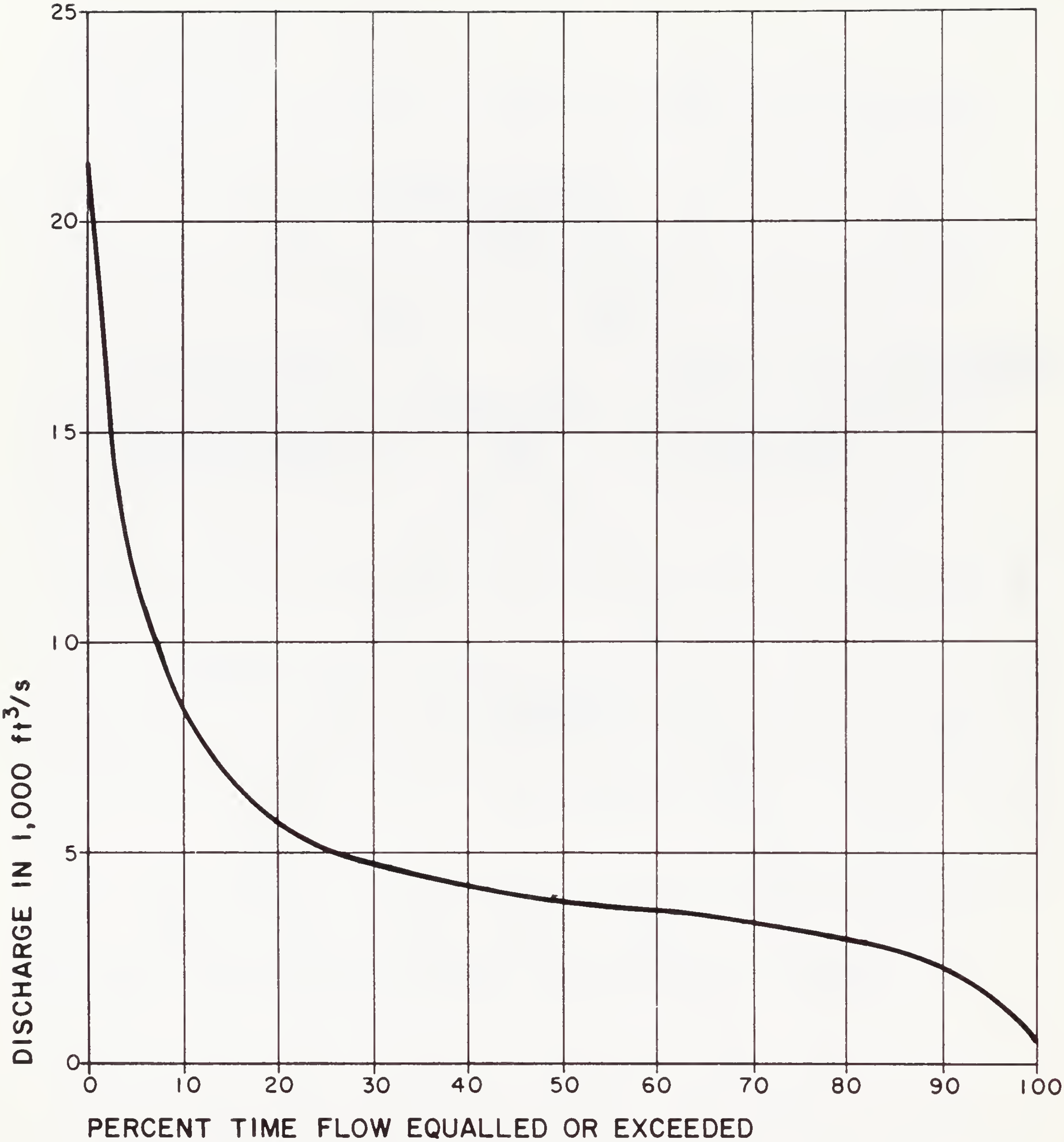
The Applicant has also initiated FERC applications at seven additional sites. They are: Nevada Creek, Preliminary Permit No. 4698; Rock Creek, Preliminary Permit No. 4700; Middle Creek, Preliminary Permit No. 4699; Deadman's Basin, Competing Preliminary Permit Application No. 4816; Tongue River, Competing Preliminary Permit Application No. 5426; Ruby River, Competing Preliminary Permit Application No. 5420; and Painted Rocks, Exemption from Licensing Application No. 4657. The Applicant is authorized by the state legislature to study the feasibility of installing hydroelectric power plants at all state water projects.



AREA - CAPACITY CURVE

EXHIBIT

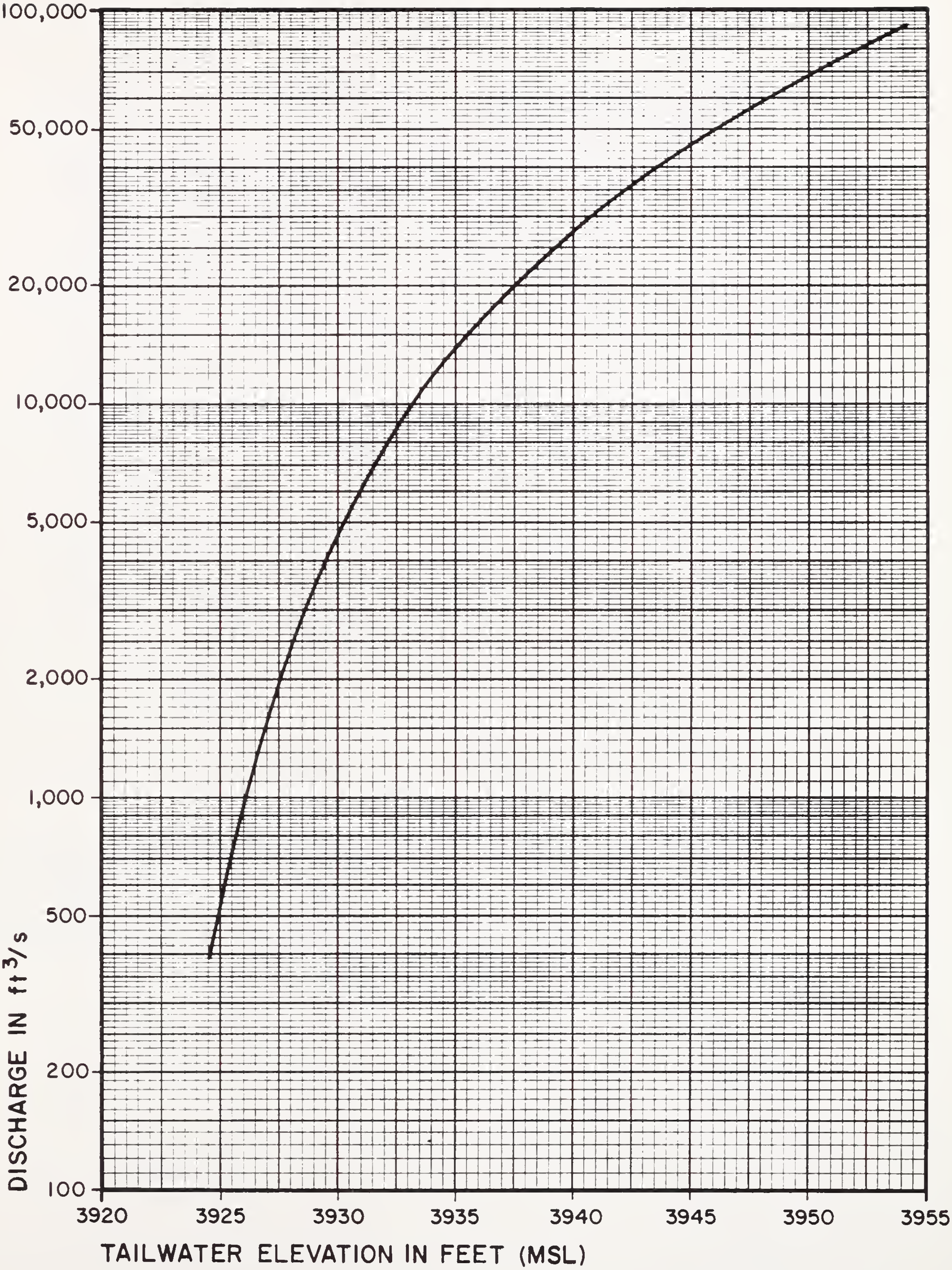
B-1



AS PER "HEC-4" PROGRAM, WATER YEAR 1929-1940
AND USGS GAGE "MISSOURI RIVER AT TOSTON",
WATER YEAR 1941-1978

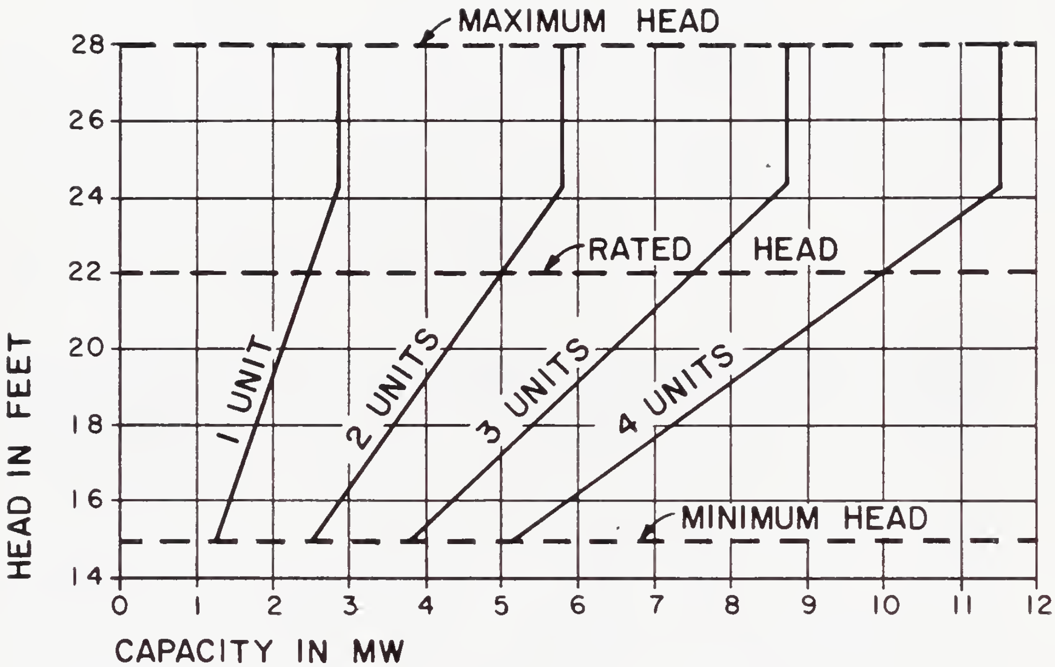
FLOW - DURATION CURVE

EXHIBIT
B-2



TAILWATER RATING CURVE

EXHIBIT
B-3



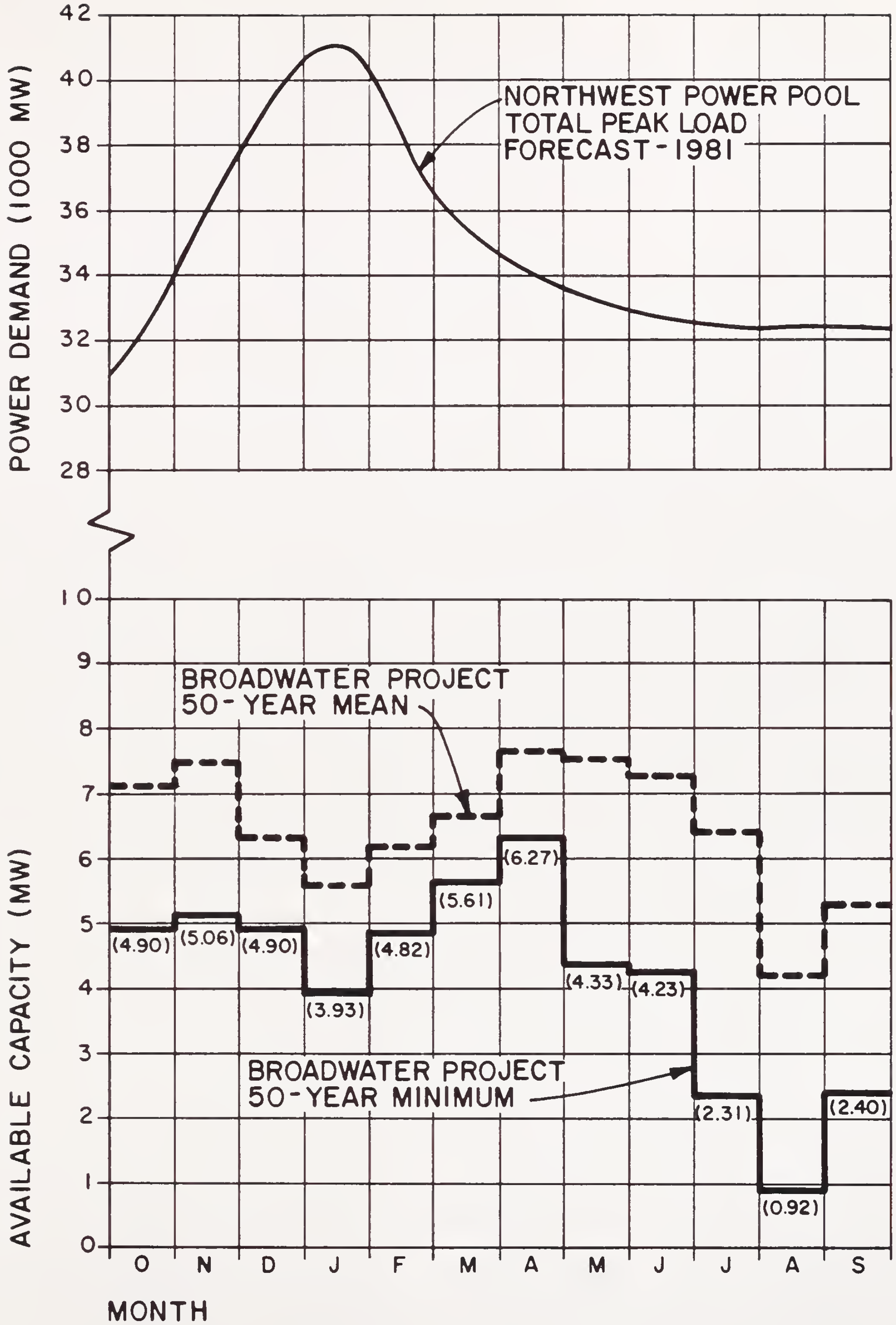
NOTES:

1. FROM TUBE TURBINE PERFORMANCE CURVE BY ALLIS-CHALMERS.
2. MAXIMUM CAPACITY IS ASSUMED TO BE 115% OF RATED CAPACITY.
3. ALL VALUES BASED ON MAXIMUM PERMISSIBLE FLOW THROUGH TURBINE(S). (1500 ft^3/s PER TURBINE)

POWER PLANT CAPABILITY

EXHIBIT

B-4



POWER VS TIME

EXHIBIT

B-5

APPENDIX B

OPERATION STUDY

BROADWATER HYDROELECTRIC PROJECT

MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION

RUN # : SP-1 FEBRUARY 1, 1979

APRON-MOUNTED ALTERNATIVE

****
* MONTHLY POWER OPERATION STUDY *
****

UNIT #	RATED CAPACITY (KW)	DESIGN CAPACITY (KW)	DESIGN FLOW (CFS)	DESIGN HEAD (FT)
1	2444	2444	1491	22
2	2444	2444	1491	22
3	2444	2444	1491	22
4	2444	2444	1491	22

YEAR	MONTH	OUTFLOW (AF)	OUTFLOW (CFS)	AVERAGE HEAD (FT)	ON-LINE UNITS	POWER (MW)	ENERGY (GWH)
1929	OCT	262000	4261	22.9	123	7.22	[illegible].37
	NOV	308000	5176	22.2	1234	8.45	[illegible].08
	DEC	229000	3724	23.3	123	6.32	4.70
	JAN	217000	3529	23.5	123	5.98	4.45
	FEB	180000	3241	23.7	123	5.48	3.68
	MAR	218000	3545	23.5	123	6.01	4.47
	APR	231000	3882	23.2	123	6.59	4.74
	MAY	213000	3464	23.5	123	5.87	4.37
	JUN	528000S	5327	19.9	1234	8.16	5.87
	JUL	285000	4635	22.6	1234	7.59	5.65
	AUG	136000	2212	24.7	12	3.9[illegible]	[illegible].88
	SEP	147000	2470	24.4	12	4.3[illegible]	[illegible].14
						TOTAL	[illegible].40
1930	OCT	271000	4407	22.8	123	7.4[illegible]	[illegible].55
	NOV	281000	4722	22.6	1234	7.73	5.27
	DEC	211000	3432	23.6	123	5.8[illegible]	4.32
	JAN	184000	2992	23.9	123	5.0[illegible]	3.74
	FEB	188000	3385	23.6	123	5.7[illegible]	3.35
	MAR	230000	3741	23.3	123	6.35	4.72
	APR	417000S	5327	20.9	1234	8.39	6.0[illegible]
	MAY	469000S	5327	20.6	1234	8.31	6.19
	JUN	343000S	5327	21.8	1234	8.53	6.18
	JUL	121000	1968	25.0	12	3.46	2.53
	AUG	103000	1675	25.4	12	2.93	2.10
	SEP	113000	1899	25.1	12	3.26	2.35
						TOTAL	53.15

YEAR	MONTH	OUTFLOW (AF)	OUTFLOW (CFS)	AVERAGE HEAD (FT)	ON-LINE UNITS	POWER (MW)	ENERGY (M WH)
1931	OCT	315000	5123	22.3	1234	[illegible]	6.22
	NOV	287000	4823	22.5	1234	7.89	5.68
	DEC	200000	3253	23.7	123	5.50	4.09
	JAN	189000	3074	23.9	123	5.18	3.85
	FEB	141000	2539	24.4	12	4.49	3.02
	MAR	234000	3806	23.3	123	6.46	4.80
	APR	255000	4285	22.9	123	7.26	5.22
	MAY	151000	2456	24.5	12	4.33	3.22
	JUN	350000S	5327	21.7	1234	8.57	6.17
	JUL	77000	1252	26.1	1	2.31	1.72
	AUG	36000	585	27.4	1	0.92	0.69
	SEP	79000	1328	26.0	1	2.46	1.77
						TOTAL	46.47
1932	OCT	186000	3025	23.9	123	5.09	3.79
	NOV	217000	3647	23.4	123	6.19	4.45
	DEC	176000	2862	24.0	12	5.06	3.78
	JAN	180000	2927	24.0	12	5.19	3.86
	FEB	150000	2701	24.2	12	4.79	3.22
	MAR	225000	3659	23.4	123	6.21	4.62
	APR	232000	3899	23.2	123	6.62	4.76
	MAY	389000S	5327	21.4	1234	8.50	6.32
	JUN	736000S	5327	18.2	1234	7.15	5.15
	JUL	214000	3480	23.5	123	5.90	4.39
	AUG	100000	1626	25.5	12	2.78	2.08
	SEP	150000	2521	24.4	12	4.45	3.21
						TOTAL	49.58
1933	OCT	240000	3903	23.2	123	6.62	4.93
	NOV	253000	4252	22.9	123	7.21	5.19
	DEC	176000	2862	24.0	12	5.08	3.78
	JAN	182000	2960	24.0	12	5.25	3.91
	FEB	155000	2791	24.1	12	4.95	3.33
	MAR	228000	3708	23.3	123	6.29	4.68
	APR	266000	4470	22.9	123	7.56	5.44
	MAY	317000	5155	22.2	1234	8.41	6.26
	JUN	763000S	5327	18.0	1234	7.03	5.06
	JUL	148000	2407	24.5	12	4.24	3.15
	AUG	92000	1496	25.7	12	2.47	1.84
	SEP	132000	2218	24.7	12	3.88	2.79
						TOTAL	50.36
1934	OCT	240000	3903	23.2	123	6.62	4.93
	NOV	237000	3983	23.1	123	6.73	[illegible]
	DEC	189000	3074	23.9	123	5.13	[illegible]
	JAN	200000	3253	23.7	123	5.50	4.09
	FEB	216000	3889	23.2	123	6.61	[illegible]
	MAR	176000	2862	24.0	12	5.08	[illegible]
	APR	222000	3731	23.3	123	6.33	4.53
	MAY	233000	3789	23.3	123	6.43	4.78
	JUN	143000	2403	24.5	12	4.23	3.05
	JUL	128000	2082	24.8	12	3.61	2.69
	AUG	49000	797	27.0	1	1.37	1.02
	SEP	77000	1294	26.0	1	2.40	1.72
						TOTAL	[illegible]

YEAR	MONTH	OUTFLOW (AF)	OUTFLOW (CFS)	AVERAGE HEAD (FT)	ON-LINE UNITS	POWER (MW)	ENERGY (MKWH)
1935	OCT	180000	2927	24.0	12	5.13	3.86
	NOV	191000	3210	23.7	123	5.42	3.90
	DEC	172000	2797	24.1	12	4.96	3.69
	JAN	222000	3610	23.4	123	6.12	4.56
	FEB	172000	3097	23.8	123	5.22	3.51
	MAR	190000	3090	23.8	123	5.23	3.87
	APR	276000	4638	22.6	1234	7.59	5.47
	MAY	208000	3383	23.6	123	5.73	4.26
	JUN	421000S	5327	20.9	1234	8.38	6.04
	JUL	93000	1512	25.7	12	2.50	1.86
	AUG	84000	1366	25.9	1	2.54	1.89
	SEP	106000	1781	25.3	12	3.04	2.19
						TOTAL	45.10
1936	OCT	183000	2976	23.9	12	5.23	3.93
	NOV	213000	3580	23.4	123	6.07	4.37
	DEC	170000	2765	24.1	12	4.90	3.65
	JAN	138000	2244	24.7	12	3.93	2.92
	FEB	152000	2737	24.2	12	4.85	3.26
	MAR	259000	4212	23.0	123	7.14	5.31
	APR	413000S	5327	21.0	1234	8.40	6.05
	MAY	677000S	5327	18.8	1234	7.54	5.61
	JUN	326000S	5327	22.0	1234	8.64	6.22
	JUL	85000	1382	25.9	1	2.57	1.91
	AUG	105000	1708	25.4	12	2.89	2.15
	SEP	109000	1832	25.2	12	3.13	2.26
						TOTAL	47.64
1937	OCT	170000	2765	24.1	12	4.90	3.65
	NOV	179000	3008	23.9	123	5.06	3.64
	DEC	174000	2830	24.1	12	5.02	3.74
	JAN	138000	2244	24.7	12	3.93	2.92
	FEB	151000	2719	24.2	12	4.82	3.24
	MAR	204000	3318	23.7	123	5.61	4.18
	APR	220000	3697	23.4	123	6.27	4.52
	MAY	186000	3025	23.9	123	5.09	3.79
	JUN	223000	3748	23.3	123	6.35	4.58
	JUL	91000	1480	25.7	12	2.44	1.81
	AUG	87000	1415	25.8	1	2.64	1.96
	SEP	117000	1966	25.0	12	3.39	2.44
						TOTAL	40.46
1938	OCT	189000	3074	23.9	123	5.13	3.85
	NOV	185000	3109	23.8	123	5.24	3.77
	DEC	166000	2700	24.2	12	4.73	3.56
	JAN	199000	3236	23.7	123	5.47	4.07
	FEB	156000	2809	24.1	12	4.98	[illegible]
	MAR	206000	3350	23.6	123	5.67	[illegible]
	APR	319000	5361	22.1	1234	8.73	[illegible]
	MAY	403000S	5327	21.2	1234	8.46	[illegible]
	JUN	644000S	5327	18.9	1234	7.59	[illegible]
	JUL	335000	5448	22.0	1234	8.8[illegible]	[illegible].59
	AUG	133000	2163	24.7	12	3.7[illegible]	2.81
	SEP	133000	2235	24.7	12	3.91	2.82
						TOTAL	5[illegible].08

YEAR	MONTH	OUTFLOW (AF)	OUTFLOW (CFS)	AVERAGE HEAD (FT)	ON-LINE UNITS	POWER (MW)	ENERGY (MKWH)
1939	OCT	278000	4521	22.7	1234	7.4[illegible]	5.51
	NOV	246000	4134	23.0	123	7.0[illegible]	5.05
	DEC	216000	3513	23.5	123	5.9[illegible]	4.43
	JAN	214000	3480	23.5	123	5.90	4.39
	FEB	149000	2683	24.2	12	4.75	3.20
	MAR	208000	3383	23.6	123	5.73	4.26
	APR	357000S	5327	21.6	1234	8.55	6.16
	MAY	652000S	5327	19.0	1234	7.66	5.70
	JUN	460000S	5327	20.5	1234	8.30	5.98
	JUL	196000	3188	23.8	123	5.38	4.00
	AUG	120000	1952	25.0	12	3.36	2.50
	SEP	117000	1966	25.0	12	3.37	2.44
						TOTAL	53.61
1940	OCT	221000	3594	23.4	123	6.10	4.54
	NOV	258000	4336	22.9	123	7.34	5.29
	DEC	195000	3171	23.8	123	5.35	3.98
	JAN	193000	3139	23.8	123	5.29	3.94
	FEB	192000	3457	23.5	123	5.86	4.54
	MAR	255000	4147	23.0	123	7.0[illegible]	5.23
	APR	306000	5142	22.2	1234	8.38	6.04
	MAY	392000S	5327	21.3	1234	8.4[illegible]	6.31
	JUN	380000S	5327	21.3	1234	8.48	6.11
	JUL	116000	1887	25.1	12	3.24	2.41
	AUG	97000	1578	25.6	12	2.63	1.96
	SEP	136000	2286	24.6	12	4.0[illegible]	2.89
						TOTAL	52.63
1941	OCT	208000	3383	23.6	123	5.73	4.26
	NOV	225000	3781	23.3	123	6.42	4.62
	DEC	188000	3057	23.9	123	5.15	3.83
	JAN	195000	3171	23.8	123	5.35	3.98
	FEB	180000	3241	23.7	123	5.48	3.68
	MAR	211000	3432	23.6	123	5.81	4.32
	APR	273000	4588	22.7	1234	7.51	5.41
	MAY	259000	4212	23.0	123	7.14	5.31
	JUN	384000S	5327	21.3	1234	8.47	6.10
	JUL	136000	2212	24.7	12	3.87	2.88
	AUG	141000	2293	24.6	12	4.02	2.99
	SEP	208000	3496	23.5	123	5.92	4.27
						TOTAL	51.65
1942	OCT	270000	4391	22.8	123	7.43	5.53
	NOV	255000	4285	22.9	123	7.26	5.23
	DEC	246000	4001	23.1	123	6.75	5.05
	JAN	183000	2976	23.9	12	5.28	3.93
	FEB	186000	3349	23.6	123	5.67	3.81
	MAR	246000	4001	23.1	123	6.73	5.05
	APR	519000S	5327	20.0	1234	8.17	5.39
	MAY	622000S	5327	19.3	1234	7.79	5.80
	JUN	943000S	5327	16.7	1234	6.46	4.65
	JUL	286000	4651	22.6	1234	7.62	5.67
	AUG	112000	1821	25.2	12	3.11	2.32
	SEP	159000	2672	24.2	12	4.73	3.41
						TOTAL	56.31

YEAR	MONTH	OUTFLOW (AF)	OUTFLOW (CFS)	AVERAGE HEAD (FT)	ON-LINE UNITS	POWER (MW)	ENERGY (MKWH)
1943	OCT	200000	3253	23.7	123	5.50	4.09
	NOV	242000	4067	23.1	123	6.90	4.97
	DEC	234000	3806	23.3	123	6.46	4.80
	JAN	191000	3106	23.8	123	5.23	3.89
	FEB	259000	4663	22.6	1234	7.64	5.13
	MAR	325000	5286	22.1	1234	8.62	6.41
	APR	515000S	5327	20.0	1234	8.18	5.89
	MAY	577000S	5327	19.6	1234	8.03	5.97
	JUN	1151000S	5116	15.4	1234	5.73	4.12
	JUL	479000S	5327	20.5	1234	8.29	6.17
	AUG	212000	3448	23.6	123	5.84	4.35
	SEP	185000	3109	23.8	123	5.24	3.77
						TOTAL	59.58
1944	OCT	224000	3643	23.4	123	6.19	4.60
	NOV	244000	4100	23.0	123	6.95	5.01
	DEC	233000	3789	23.3	123	6.43	4.78
	JAN	225000	3659	23.4	123	6.21	4.62
	FEB	201000	3619	23.4	123	6.14	4.13
	MAR	216000	3513	23.5	123	5.95	4.43
	APR	220000	3697	23.4	123	6.27	4.52
	MAY	279000	4537	22.7	1234	7.43	5.53
	JUN	823000S	5327	17.5	1234	6.76	4.87
	JUL	427000S	5327	21.0	1234	8.40	6.25
	AUG	180000	2927	24.0	12	5.19	3.86
	SEP	196000	3294	23.7	123	5.57	4.01
						TOTAL	56.60
1945	OCT	207000	3366	23.6	123	5.70	4.24
	NOV	219000	3680	23.4	123	6.24	4.50
	DEC	198000	3220	23.7	123	5.44	4.05
	JAN	237000	3854	23.2	123	6.54	4.87
	FEB	207000	3727	23.3	123	6.32	4.25
	MAR	201000	3269	23.7	123	5.53	4.11
	APR	193000	3243	23.7	123	5.48	3.95
	MAY	320000	5204	22.2	1234	8.49	6.32
	JUN	571000S	5327	19.5	1234	7.96	5.73
	JUL	268000	4359	22.8	123	7.38	5.49
	AUG	153000	2488	24.4	12	4.39	3.27
	SEP	174000	2924	24.0	12	5.19	3.73
						TOTAL	54.50
1946	OCT	213000	3464	23.5	123	5.87	4.37
	NOV	220000	3697	23.4	123	6.27	4.52
	DEC	207000	3366	23.6	123	5.70	4.24
	JAN	218000	3545	23.5	123	6.01	4.47
	FEB	208000	3745	23.3	123	6.36	4.27
	MAR	259000	4212	23.0	123	7.14	5.31
	APR	357000S	5327	21.6	1234	8.55	6.16
	MAY	467000S	5327	20.6	1234	8.32	6.19
	JUN	435000S	5327	20.8	1234	8.35	6.02
	JUL	234000	3806	23.3	123	6.45	4.80
	AUG	151000	2456	24.5	12	4.33	3.22
	SEP	215000	3613	23.4	123	6.13	4.41
						TOTAL	57.98

YEAR	MONTH	OUTFLOW (AF)	OUTFLOW (CFS)	AVERAGE HEAD (FT)	ON-LINE UNITS	POWER (MW)	ENERGY (MKWH)
1947	OCT	260000	4228	22.9	123	7.17	5.33
	NOV	267000	4487	22.7	1234	7.35	5.29
	DEC	277000	4505	22.7	1234	7.38	5.49
	JAN	225000	3659	23.4	123	6.21	4.62
	FEB	206000	3709	23.3	123	6.29	4.23
	MAR	316000	5139	22.3	1234	8.39	6.24
	APR	450000S	5327	20.6	1234	8.32	5.99
	MAY	797000S	5327	17.9	1234	6.99	5.20
	JUN	882000S	5327	17.1	1234	6.63	4.75
	JUL	351000S	5327	21.8	1234	8.63	6.40
	AUG	183000	2976	23.9	12	5.28	3.93
	SEP	235000	3949	23.2	123	6.70	4.83
						TOTAL	62.30
1948	OCT	300000	4879	22.4	1234	7.98	5.94
	NOV	280000	4705	22.6	1234	7.70	5.55
	DEC	280000	4554	22.7	1234	7.46	5.55
	JAN	245000	3984	23.1	123	6.76	5.03
	FEB	220000	3961	23.1	123	6.72	4.52
	MAR	277000	4505	22.7	1234	7.38	5.49
	APR	499000S	5327	20.2	1234	8.21	5.92
	MAY	895000S	5327	17.2	1234	6.61	4.94
	JUN	1213000S	5116	15.0	1234	5.57	4.01
	JUL	398000S	5327	21.3	1234	8.47	6.30
	AUG	219000	3562	23.5	123	6.04	4.49
	SEP	208000	3496	23.5	123	5.92	4.27
						TOTAL	62.00
1949	OCT	261000	4245	22.9	123	7.13	5.25
	NOV	261000	4386	22.8	123	7.42	5.35
	DEC	236000	3838	23.2	123	6.51	4.85
	JAN	197000	3204	23.7	123	5.41	4.07
	FEB	192000	3457	23.5	123	5.86	3.94
	MAR	271000	4407	22.8	123	7.46	5.55
	APR	490000S	5327	20.3	1234	8.24	5.93
	MAY	626000S	5327	19.2	1234	7.77	5.78
	JUN	521000S	5327	20.0	1234	8.17	5.88
	JUL	182000	2960	24.0	12	5.25	3.91
	AUG	130000	2114	24.8	12	3.68	2.74
	SEP	198000	3327	23.6	123	5.62	4.05
						TOTAL	57.35
1950	OCT	233000	3789	23.3	123	6.41	4.78
	NOV	236000	3966	23.1	123	6.73	4.84
	DEC	207000	3366	23.6	123	5.70	4.24
	JAN	184000	2992	23.9	123	5.03	3.74
	FEB	203000	3655	23.4	123	6.20	4.17
	MAR	241000	3919	23.2	123	6.65	4.95
	APR	294000	4941	22.4	1234	8.03	5.82
	MAY	331000	5383	22.1	1234	8.76	6.52
	JUN	708000S	5327	18.4	1234	7.29	5.25
	JUL	372000S	5327	21.6	1234	8.54	6.36
	AUG	203000	3301	23.7	123	5.58	4.15
	SEP	237000	3983	23.1	123	6.76	4.87
						TOTAL	59.68

YEAR	MONTH	OUTFLOW (AF)	OUTFLOW (CFS)	AVERAGE HEAD (FT)	ON-LINE UNITS	POWER (MW)	ENERGY (MKWH)
1951	OCT	289000	4700	22.6	1234	7.70	5.73
	NOV	275000	4621	22.6	1234	7.57	5.45
	DEC	267000	4342	22.9	123	7.35	5.47
	JAN	207000	3366	23.6	123	5.70	4.24
	FEB	215000	3871	23.2	123	6.57	4.42
	MAR	250000	4066	23.1	123	6.90	5.13
	APR	334000S	5327	21.9	1234	8.62	6.20
	MAY	677000S	5327	18.8	1234	7.54	5.61
	JUN	550000S	5327	19.7	1234	8.08	5.82
	JUL	234000	3806	23.3	123	6.46	4.80
	AUG	201000	3269	23.7	123	5.53	4.11
	SEP	221000	3714	23.3	123	6.30	4.54
						TOTAL	61.52
1952	OCT	255000	4147	23.0	123	7.03	5.23
	NOV	251000	4218	22.9	123	7.15	5.15
	DEC	201000	3269	23.7	123	5.53	4.11
	JAN	193000	3139	23.8	123	5.29	3.94
	FEB	226000	4069	23.1	123	6.90	4.64
	MAR	259000	4212	23.0	123	7.14	5.31
	APR	499000S	5327	20.2	1234	8.22	5.92
	MAY	904000S	5327	17.1	1234	6.62	4.92
	JUN	713000S	5327	18.4	1234	7.26	5.23
	JUL	317000	5155	22.2	1234	8.41	6.26
	AUG	176000	2862	24.0	12	5.08	3.78
	SEP	215000	3613	23.4	123	6.13	4.41
						TOTAL	58.90
1953	OCT	226000	3675	23.4	123	6.23	4.64
	NOV	247000	4151	23.0	123	7.04	5.07
	DEC	254000	4131	23.0	123	7.01	5.21
	JAN	250000	4066	23.1	123	6.90	5.13
	FEB	198000	3565	23.5	123	6.04	4.06
	MAR	213000	3464	23.5	123	5.87	4.37
	APR	225000	3781	23.3	123	6.42	4.62
	MAY	283000	4602	22.7	1234	7.54	5.61
	JUN	907000S	5327	16.9	1234	6.54	4.71
	JUL	291000	4733	22.6	1234	7.75	5.76
	AUG	143000	2326	24.6	12	4.03	3.04
	SEP	178000	2991	23.9	123	5.03	3.62
						TOTAL	55.33
1954	OCT	254000	4131	23.0	123	7.01	5.21
	NOV	269000	4521	22.7	1234	7.40	5.33
	DEC	221000	3594	23.4	123	6.10	4.54
	JAN	182000	2960	24.0	12	5.25	3.91
	FEB	211000	3799	23.3	123	6.45	4.33
	MAR	202000	3285	23.7	123	5.56	4.13
	APR	227000	3815	23.3	123	6.47	4.66
	MAY	310000	5042	22.3	1234	8.24	6.13
	JUN	365000S	5327	21.5	1234	8.53	6.14
	JUL	252000	4098	23.0	123	6.95	5.17
	AUG	139000	2261	24.6	12	3.96	2.95
	SEP	153000	2571	24.3	12	4.55	3.37
						TOTAL	55.77

YEAR	MONTH	OUTFLOW (AF)	OUTFLOW (CFS)	AVERAGE HEAD (FT)	ON-LINE UNITS	POWER (MW)	ENERGY (MKWH)
1955	OCT	224000	3643	23.4	123	6.13	4.60
	NOV	241000	4050	23.1	123	6.87	4.95
	DEC	173000	2814	24.1	12	4.99	3.71
	JAN	167000	2716	24.2	12	4.92	3.58
	FEB	147000	2647	24.3	12	4.69	3.15
	MAR	174000	2830	24.1	12	5.02	3.74
	APR	214000	3596	23.4	123	6.10	4.39
	MAY	348000S	5327	21.9	1234	8.61	6.40
	JUN	507000S	5327	20.1	1234	8.23	5.90
	JUL	321000	5220	22.2	1234	8.52	6.34
	AUG	116000	1887	25.1	12	3.24	2.41
	SEP	146000	2454	24.5	12	4.33	3.11
						TOTAL	52.29
1956	OCT	201000	3269	23.7	123	5.53	4.11
	NOV	235000	3949	23.2	123	6.70	4.83
	DEC	230000	3741	23.3	123	6.35	4.72
	JAN	225000	3659	23.4	123	6.21	4.62
	FEB	158000	2845	24.1	12	5.05	3.39
	MAR	290000	4716	22.6	1234	7.72	5.75
	APR	387000S	5327	21.3	1234	8.47	6.10
	MAY	726000S	5327	18.5	1234	7.01	5.44
	JUN.	636000S	5327	19.0	1234	7.63	5.49
	JUL	174000	2830	24.1	12	5.02	3.74
	AUG	130000	2114	24.8	12	3.68	2.74
	SEP	167000	2806	24.1	12	4.99	.58
						TOTAL	54.50
1957	OCT	230000	3741	23.3	123	6.35	4.72
	NOV	293000	4924	22.4	1234	8.05	5.80
	DEC	202000	3285	23.7	123	5.56	4.13
	JAN	151000	2456	24.5	12	4.33	3.22
	FEB	188000	3385	23.6	123	5.73	3.85
	MAR	224000	3643	23.4	123	6.18	4.60
	APR	246000	4134	23.0	123	7.01	5.05
	MAY	586000S	5327	19.6	1234	7.98	5.94
	JUN	721000S	5327	18.3	1234	7.23	5.20
	JUL	232000	3773	23.3	123	6.40	4.76
	AUG	109000	1773	25.3	12	3.02	2.25
	SEP	171000	2874	24.0	12	5.19	3.67
						TOTAL	53.19
1958	OCT	275000	4472	22.8	123	7.57	5.63
	NOV	298000	5008	22.4	1234	8.14	5.89
	DEC	238000	3871	23.2	123	6.57	4.89
	JAN	201000	3269	23.7	123	5.53	4.11
	FEB	196000	3529	23.5	123	5.98	4.02
	MAR	219000	3562	23.5	123	6.04	4.49
	APR	264000	4437	22.8	123	7.51	5.41
	MAY	558000S	5327	19.8	1234	8.13	6.05
	JUN	506000S	5327	20.1	1234	8.20	5.91
	JUL	228000	3708	23.3	123	6.29	4.68
	AUG	131000	2130	24.8	12	3.71	2.76
	SEP	153000	2571	24.3	12	4.55	3.27
						TOTAL	57.11

YEAR	MONTH	OUTFLOW (AF)	OUTFLOW (CFS)	AVERAGE HEAD (FT)	ON-LINE UNITS	POWER (MW)	ENERGY (MKWH)
1959	OCT	240000	3903	23.2	123	6.62	4.93
	NOV	258000	4336	22.9	123	7.34	5.29
	DEC	225000	3659	23.4	123	6.21	4.62
	JAN	189000	3074	23.9	123	5.10	3.85
	FEB	156000	2809	24.1	12	4.98	3.35
	MAR	238000	3871	23.2	123	6.57	4.89
	APR	281000	4722	22.6	1234	7.73	5.57
	MAY	306000	4977	22.4	1234	8.14	6.05
	JUN	693000S	5327	18.6	1234	7.36	5.30
	JUL	277000	4505	22.7	1234	7.38	5.49
	AUG	100000	1626	25.5	12	2.73	2.03
	SEP	151000	2538	24.4	12	4.49	3.23
						TOTAL	54.59
1960	OCT	365000S	5327	21.7	1234	8.56	6.37
	NOV	390000S	5327	21.2	1234	8.40	6.09
	DEC	367000S	5327	21.6	1234	8.56	6.37
	JAN	204000	3318	23.7	123	5.61	4.18
	FEB	219000	3943	23.2	123	6.69	4.50
	MAR	349000S	5327	21.9	1234	8.61	6.40
	APR	419000S	5327	20.9	1234	8.39	6.04
	MAY	447000S	5327	20.8	1234	8.36	6.22
	JUN	422000S	5327	20.9	1234	8.38	6.04
	JUL	109000	1773	25.3	12	3.02	2.25
	AUG	104000	1691	25.4	12	2.86	2.13
	SEP	143000	2403	24.5	12	4.23	3.05
						TOTAL	59.61
1961	OCT	177000	2879	24.0	12	5.11	3.80
	NOV	219000	3680	23.4	123	6.24	4.50
	DEC	199000	3236	23.7	123	5.47	4.07
	JAN	182000	2960	24.0	12	5.25	3.91
	FEB	188000	3385	23.6	123	5.73	3.85
	MAR	185000	3009	23.9	123	5.06	3.76
	APR	142000	2386	24.5	12	4.20	3.02
	MAY	192000	3123	23.8	123	5.26	3.92
	JUN	308000	5176	22.2	1234	8.45	6.08
	JUL	85000	1382	25.9	1	2.57	1.91
	AUG	66000	1073	26.4	1	1.95	1.45
	SEP	176000	2958	24.0	12	5.25	3.78
						TOTAL	44.05
1962	OCT	305000	4960	22.4	1234	8.11	6.03
	NOV	312000	5243	22.2	1234	8.55	6.16
	DEC	188000	3057	23.9	123	5.15	3.83
	JAN	153000	2488	24.4	12	4.39	3.27
	FEB	196000	3529	23.5	123	5.98	4.02
	MAR	232000	3773	23.3	123	6.40	4.76
	APR	379000S	5327	21.4	1234	8.49	6.11
	MAY	480000S	5327	20.5	1234	8.20	6.17
	JUN	641000S	5327	19.0	1234	7.61	5.48
	JUL	270000	4391	22.8	123	7.43	5.53
	AUG	174000	2830	24.1	12	5.02	3.74
	SEP	215000	3613	23.4	123	6.13	4.41
						TOTAL	59.51

YEAR	MONTH	OUTFLOW (AF)	OUTFLOW (CFS)	AVERAGE HEAD (FT)	ON-LINE UNITS	POWER (MW)	ENERGY (MKWH)
1963	OCT	292000	4749	22.5	1234	7.77	5.78
	NOV	306000	5142	22.2	1234	8.33	6.04
	DEC	252000	4098	23.0	123	6.95	5.17
	JAN	175000	2846	24.1	12	5.05	3.76
	FEB	271000	4880	22.4	1234	7.99	5.36
	MAR	219000	3562	23.5	123	6.04	4.49
	APR	235000	3949	23.2	123	6.70	4.83
	MAY	477000S	5327	20.5	1234	8.30	6.17
	JUN	826000S	5327	17.5	1234	6.75	4.86
	JUL	272000	4424	22.8	123	7.49	5.57
	AUG	121000	1968	25.0	12	3.40	2.53
	SEP	204000	3428	23.6	123	5.81	4.18
						TOTAL	58.75
1964	OCT	247000	4017	23.1	123	6.81	5.07
	NOV	291000	4890	22.4	1234	8.00	5.76
	DEC	199000	3236	23.7	123	5.47	4.07
	JAN	199000	3236	23.7	123	5.47	4.07
	FEB	189000	3403	23.6	123	5.75	3.87
	MAR	208000	3383	23.6	123	5.73	4.26
	APR	249000	4185	23.0	123	7.10	5.11
	MAY	470000S	5327	20.6	1234	8.31	6.18
	JUN	1063000S	5327	15.9	1234	6.19	4.46
	JUL	417000S	5327	21.1	1234	8.42	6.27
	AUG	159000	2586	24.3	12	4.57	3.40
	SEP	219000	3680	23.4	123	6.24	4.50
						TOTAL	57.02
1965	OCT	250000	4066	23.1	123	6.90	5.13
	NOV	297000	4991	22.4	1234	8.15	5.87
	DEC	232000	3773	23.3	123	6.43	4.76
	JAN	256000	4163	23.0	123	7.05	5.25
	FEB	228000	4105	23.0	123	6.96	4.68
	MAR	230000	3741	23.3	123	6.35	4.72
	APR	390000S	5327	21.2	1234	8.46	6.09
	MAY	612000S	5327	19.3	1234	7.84	5.83
	JUN	1069000S	5327	15.9	1234	6.19	4.45
	JUL	604000S	5327	19.4	1234	7.88	5.86
	AUG	242000	3936	23.2	123	6.68	4.97
	SEP	279000	4689	22.6	1234	7.68	5.53
						TOTAL	63.16
1966	OCT	349000S	5327	21.9	1234	8.61	6.40
	NOV	379000S	5327	21.4	1234	8.49	6.11
	DEC	250000	4066	23.1	123	6.90	5.13
	JAN	230000	3741	23.3	123	6.35	4.72
	FEB	209000	3763	23.3	123	6.39	4.29
	MAR	239000	3887	23.2	123	6.60	4.91
	APR	261000	4386	22.8	123	7.42	5.35
	MAY	271000	4407	22.8	123	7.46	5.55
	JUN	238000	4000	23.1	123	6.79	4.89
	JUL	121000	1968	25.0	12	3.40	2.53
	AUG	77000	1252	26.1	1	2.31	1.72
	SEP	121000	2033	24.9	12	3.52	2.54
						TOTAL	54.13

YEAR	MONTH	OUTFLOW (AF)	OUTFLOW (CFS)	AVERAGE HEAD (FT)	ON-LINE UNITS	POWER (MW)	ENERGY (MKWH)
1967	OCT	250000	4066	23.1	123	6.90	5.13
	NOV	286000	4806	22.5	1234	7.87	5.66
	DEC	202000	3285	23.7	123	5.55	4.13
	JAN	209000	3399	23.6	123	5.76	4.28
	FEB	188000	3385	23.6	123	5.73	3.85
	MAR	197000	3204	23.7	123	5.41	4.02
	APR	211000	3546	23.5	123	6.01	4.33
	MAY	569000S	5327	19.7	1234	8.07	6.01
	JUN	1269000S	5116	14.6	1234	5.42	3.91
	JUL	461000S	5327	20.7	1234	8.33	6.20
	AUG	147000	2391	24.5	12	4.21	3.13
	SEP	199000	3344	23.6	123	5.66	4.07
						TOTAL	54.73
1968	OCT	302000	4911	22.4	1234	8.03	5.98
	NOV	309000	5193	22.2	1234	8.47	6.10
	DEC	228000	3708	23.3	123	6.29	4.68
	JAN	225000	3659	23.4	123	6.21	4.62
	FEB	254000	4573	22.7	1234	7.49	5.03
	MAR	278000	4521	22.7	1234	7.40	5.51
	APR	299000	5025	22.3	1234	8.21	5.91
	MAY	460000S	5327	20.7	1234	8.33	6.20
	JUN	1041000S	5327	16.1	1234	6.24	4.49
	JUL	360000S	5327	21.7	1234	8.58	6.38
	AUG	233000	3789	23.3	123	6.43	4.78
	SEP	298000	5008	22.4	1234	8.19	5.89
						TOTAL	65.58
1969	OCT	321000	5220	22.2	1234	8.52	6.34
	NOV	322000	5411	22.0	1234	8.81	6.34
	DEC	244000	3968	23.1	123	6.73	5.01
	JAN	226000	3675	23.4	123	6.23	4.64
	FEB	240000	4321	22.9	123	7.32	4.92
	MAR	306000	4977	22.4	1234	8.14	6.05
	APR	600000S	5327	19.3	1234	7.80	5.62
	MAY	894000S	5327	17.2	1234	6.65	4.94
	JUN	652000S	5327	18.9	1234	7.55	5.44
	JUL	434000S	5327	20.9	1234	8.39	6.24
	AUG	189000	3074	23.9	123	5.18	3.85
	SEP	202000	3395	23.6	123	5.75	4.14
						TOTAL	63.52
1970	OCT	327000	5318	22.1	1234	8.66	6.45
	NOV	302000	5075	22.3	1234	8.29	5.97
	DEC	249000	4050	23.1	123	6.87	5.11
	JAN	230000	3741	23.3	123	6.35	4.72
	FEB	214000	3853	23.2	123	6.54	4.39
	MAR	235000	3822	23.3	123	6.49	4.83
	APR	259000	4353	22.8	123	7.37	5.31
	MAY	714000S	5327	18.6	1234	7.37	5.48
	JUN	1117000S	5327	15.6	1234	6.07	4.37
	JUL	467000S	5327	20.6	1234	8.33	6.19
	AUG	186000	3025	23.9	123	5.09	3.79
	SEP	262000	4403	22.8	123	7.45	5.37
						TOTAL	61.97

YEAR	MONTH	OUTFLOW (AF)	OUTFLOW (CFS)	AVERAGE HEAD (FT)	ON-LINE UNITS	POWER (MW)	ENERGY (MKWH)
1971	OCT	332000	5399	22.1	1234	8.79	6.54
	NOV	339000S	5327	21.8	1234	8.60	6.19
	DEC	259000	4212	23.0	123	7.14	5.31
	JAN	259000	4212	23.0	123	7.14	5.31
	FEB	266000	4790	22.5	1234	7.84	5.27
	MAR	241000	3919	23.2	123	6.65	4.95
	APR	402000S	5327	21.1	1234	8.42	6.07
	MAY	784000S	5327	18.0	1234	7.05	5.24
	JUN	1080000S	5327	15.8	1234	6.15	4.43
	JUL	510000S	5327	20.2	1234	8.23	6.12
	AUG	214000	3480	23.5	123	5.90	4.39
	SEP	290000	4874	22.5	1234	7.97	5.74
						TOTAL	65.57
1972	OCT	348000S	5327	21.9	1234	8.61	6.40
	NOV	339000S	5327	21.8	1234	8.60	6.19
	DEC	248000	4033	23.1	123	6.84	5.09
	JAN	252000	4098	23.0	123	6.95	5.17
	FEB	261000	4699	22.6	1234	7.70	5.17
	MAR	331000	5383	22.1	1234	8.76	6.52
	APR	398000S	5327	21.1	1234	8.43	6.07
	MAY	574000S	5327	19.7	1234	8.05	5.99
	JUN	957000S	5327	16.6	1234	6.43	4.63
	JUL	296000	4814	22.5	1234	7.88	5.86
	AUG	189000	3074	23.9	123	5.18	3.85
	SEP	239000	4016	23.1	123	6.81	4.91
						TOTAL	65.85
1973	OCT	354000S	5327	21.8	1234	8.59	6.39
	NOV	357000S	5327	21.6	1234	8.55	6.16
	DEC	225000	3659	23.4	123	6.21	4.62
	JAN	225000	3659	23.4	123	6.21	4.62
	FEB	216000	3889	23.2	123	6.60	4.43
	MAR	254000	4131	23.0	123	7.01	5.21
	APR	286000	4806	22.5	1234	7.87	5.66
	MAY	432000S	5327	20.9	1234	8.39	6.24
	JUN	442000S	5327	20.7	1234	8.34	6.00
	JUL	206000	3350	23.6	123	5.67	4.22
	AUG	120000	1952	25.0	12	3.36	2.50
	SEP	222000	3731	23.3	123	6.33	4.56
						TOTAL	60.62
1974	OCT	272000	4424	22.8	123	7.49	5.57
	NOV	316000	5310	22.1	1234	8.65	6.23
	DEC	250000	4066	23.1	123	6.99	5.13
	JAN	223000	3627	23.4	123	6.15	4.58
	FEB	219000	3943	23.2	123	6.69	4.50
	MAR	272000	4424	22.8	123	7.49	5.57
	APR	412000S	5327	21.0	1234	8.42	6.05
	MAY	539000S	5327	20.0	1234	8.17	6.08
	JUN	1032000S	5327	16.1	1234	6.25	4.51
	JUL	324000	5269	22.2	1234	8.59	6.39
	AUG	181000	2944	24.0	12	5.22	3.88
	SEP	204000	3428	23.6	123	5.81	4.18
						TOTAL	62.67

YEAR	MONTH	OUTFLOW (AF)	OUTFLOW (CFS)	AVERAGE HEAD (FT)	ON-LINE UNITS	POWER (MW)	ENERGY (MKWH)
1975	OCT	294000	4781	22.5	1234	7.83	5.82
	NOV	268000	4504	22.7	1234	7.32	5.31
	DEC	256000	4163	23.0	123	7.06	5.25
	JAN	209000	3399	23.6	123	5.76	4.28
	FEB	194000	3493	23.5	123	5.92	3.98
	MAR	252000	4098	23.0	123	6.95	5.17
	APR	291000	4890	22.4	1234	8.00	5.76
	MAY	620000S	5327	19.3	1234	7.80	5.81
	JUN	1164000S	5116	15.3	1234	5.70	4.10
	JUL	876000S	5327	17.4	1234	6.69	4.98
	AUG	352000S	5327	21.8	1234	8.60	6.40
	SEP	283000	4756	22.5	1234	7.79	5.61
						TOTAL	62.46
1976	OCT	382000S	5327	21.5	1234	8.52	6.34
	NOV	375000S	5327	21.4	1234	8.50	6.12
	DEC	351000S	5327	21.8	1234	8.60	6.40
	JAN	283000	4603	22.7	1234	7.54	5.61
	FEB	244000	4293	22.8	123	7.44	5.00
	MAR	301000	4895	22.4	1234	8.01	5.96
	APR	524000S	5327	20.0	1234	8.17	5.88
	MAY	1132000S	5327	15.7	1234	6.12	4.55
	JUN	896000S	5327	17.0	1234	6.56	4.72
	JUL	393000S	5327	21.3	1234	8.42	6.31
	AUG	350000S	5327	21.8	1234	8.63	6.40
	SEP	314000	5277	22.1	1234	8.6[illegible]	6.19
						TOTAL	69.48
1977	OCT	417000S	5327	21.1	1234	8.42	6.27
	NOV	378000S	5327	21.4	1234	8.49	6.11
	DEC	286000	4651	22.6	1234	7.62	5.67
	JAN	227000	3692	23.4	123	6.26	4.66
	FEB	214000	3853	23.2	123	6.54	4.39
	MAR	220000	3578	23.4	123	6.07	4.51
	APR	292000	4907	22.4	1234	8.03	5.78
	MAY	211000	3432	23.6	123	5.81	4.32
	JUN	315000	5294	22.1	1234	8.63	6.21
	JUL	123000	2000	24.9	12	3.4[illegible]	2.57
	AUG	104000	1691	25.4	12	2.8[illegible]	2.13
	SEP	188000	3159	23.8	123	5.3[illegible]	3.84
						TOTAL	5[illegible].46
1978	OCT	285000	4635	22.6	1234	7.59	5.65
	NOV	276000	4638	22.6	1234	7.59	5.47
	DEC	243000	3952	23.1	123	6.70	4.99
	JAN	226000	3675	23.4	123	6.23	4.64
	FEB	207000	3727	23.3	123	6.32	4.25
	MAR	324000	5269	22.2	1234	8.59	6.39
	APR	428000S	5327	20.8	1234	8.37	6.03
	MAY	591000S	5327	19.5	1234	7.96	5.92
	JUN	679000S	5327	18.7	1234	7.43	5.35
	JUL	421000S	5327	21.0	1234	8.41	6.26
	AUG	172000	2797	24.1	12	4.9[illegible]	3.69
	SEP	279000	4689	22.6	1234	7.63	5.53
						TOTAL	64.16

AVERAGE ANNUAL ENERGY = 56.44 MKWH

EXHIBIT C

CONSTRUCTION HISTORY AND SCHEDULE

EXHIBIT C

CONSTRUCTION HISTORY AND SCHEDULE

C.1 EXISTING FACILITIES

Construction began on Broadwater Dam in July, 1939. The first stage of the project was construction of the canal and the canal headworks near the left abutment. Work on this portion was completed in December, 1939.

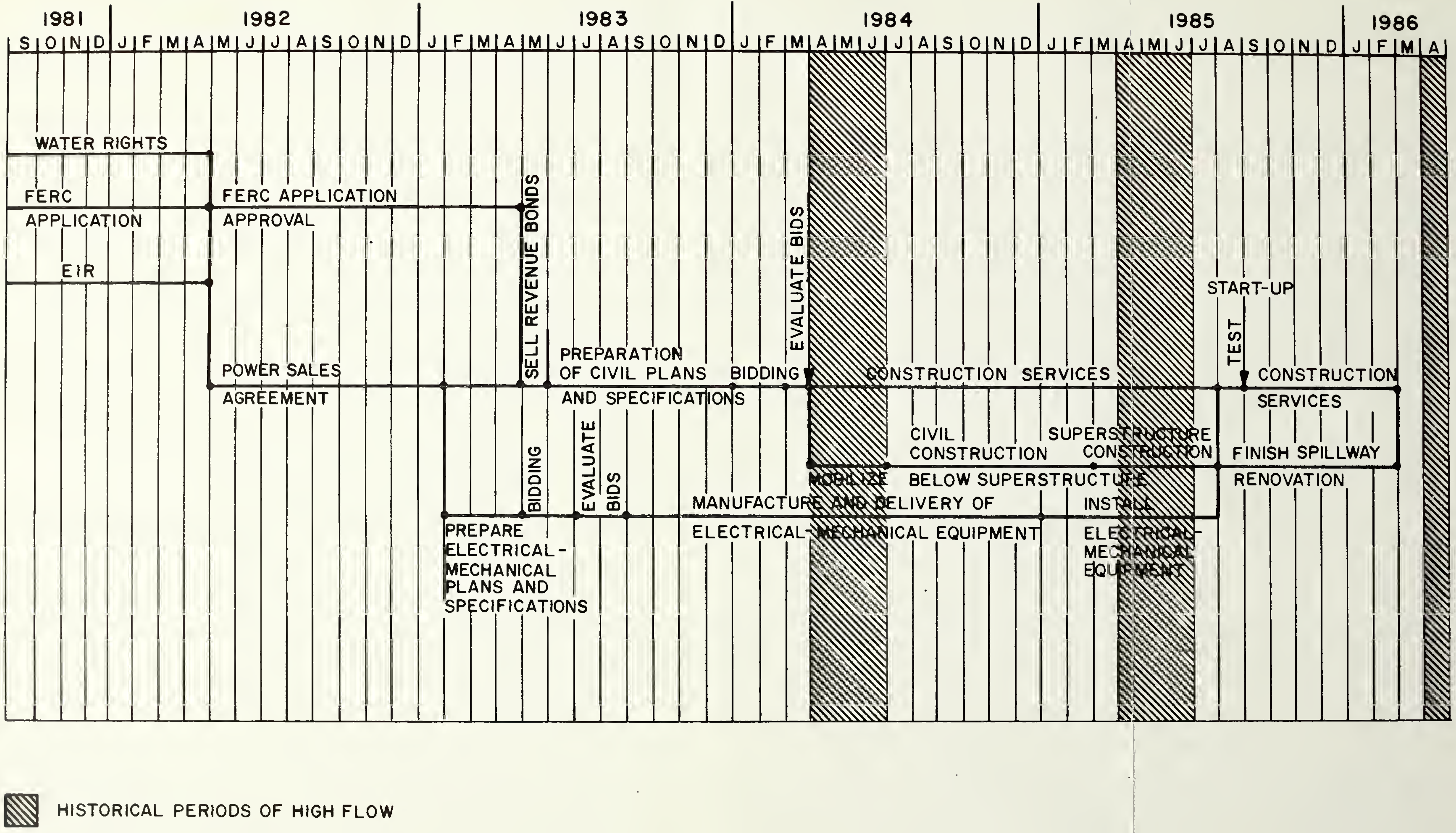
The second stage, construction of the dam itself, proceeded normally although there was some initial difficulty dewatering the cofferdam area. The cofferdams were finally sealed in early March, 1940 by means of pressure-grouting and some light blasting, the latter which helped settle the embankments. The dam was eventually completed in the early fall, and water began flowing over the crest of the dam and through the sluice gates on September 29, 1940. On October 16, 1940 water was turned into the diversion canal for the first time.

Other than routine maintenance, there have been no major changes or additions made to the Broadwater Dam since its completion in 1940.

C.2 NEW FACILITIES

A proposed schedule for completion of the Broadwater Power Project is shown in Exhibit C-1. Construction would include a temporary installation of bulkheads at the upstream end of the new turbine bays so that the new piers and radial gates may be constructed without interference from the river. The remaining spillway bays, which are also to be refurbished with new piers and radial gates, would be temporarily protected in a similar manner during construction.

Once the radial gates are installed in the turbine bays, they will be lowered and a cofferdam built downstream. The rest of the turbine bays will then be constructed. Construction on the new canal inlet structure would begin in the early fall after the irrigation season has ended. Completion of the remaining spillways and the new inlet structure would not be scheduled until after the power plant comes on line.



PROJECT DEVELOPMENT PLAN

EXHIBIT C-1

EXHIBIT D

COSTS AND FINANCING

EXHIBIT D

COSTS AND FINANCING

D.1 COST OF EXISTING FACILITIES

The Broadwater - Missouri Diversion Project was constructed during 1939 and 1940 under the direction of the Montana State Water Conservation Board through financing by the Public Works Administration. The allotment for construction was $900,000 and consisted of a loan of $495,000 and a grant of $405,000. The loan was amortized over a period of 27 years at an interest rate of 4 percent.

The Board awarded two main contracts for construction of the project. Utah Construction Company was awarded $642,211 to build the dam, relocate 3.5 miles of railroad track, construct the main canal, and construct the inverted siphons for the Missouri River crossing and the west side canal. Approximately 61 percent of the bid price was allocated for the cost of the dam, 19 percent for the railroad, and 20 percent for the canal and siphons. The contract for construction of the east and west side canals was awarded to the firm of Douglas and Genger for $138,439.

D.2 RECAPTURE VALUE

The Applicant is a state as defined by FERC. Therefore, the Applicant is exempt from stating the recapture value of the project. The Applicant is also owner of the existing project works.

D.3 PROJECT CAPITAL COSTS

The capital costs consist of direct construction costs and indirect costs for services in support of construction. Indirect construction costs include engineering services, as well as administrative, financial and legal costs.

The construction costs are summarized in Table D-1 and include 15 percent for contingencies. The estimate reflects prices as of February, 1982, and is based on bid prices for similar construction work and quotes from manufacturers for the principal mechanical and electrical equipment. A detailed breakdown of estimated construction costs by FERC account number is presented in Table D-4.

Engineering services represent about 15 percent of direct construction costs plus contingencies or $16,100,000 (see Table D-1). These costs include final design drawings, contract plans and specifications, construction management, and miscellaneous permits.

Administrative, financial and legal costs represent about three percent of direct construction costs plus contingencies or $420,000 (see Table D-1). These costs include the administrative cost to the State of Montana to oversee the project, legal fees, and financial and bond consultant fees.

Interest during construction is based on a 24-month construction period, and includes the value of investing the proceeds of the bonds during the 24-month period. The formula for investing the proceeds assumes an investment efficiency of 50 percent. The estimate for interest during construction is $2,360,000. Project financing was assumed to be obtained through tax-exempt bonds with an interest rate of 12 percent.

The total capital cost was escalated to February 1984, the expected bid date for the project. An inflation rate of 10 percent, compounded annually, was assumed for the two-year period. Total capital cost in 1984 is estimated at $22,900.00.

D.4 PROJECT ANNUAL COSTS

The annual costs for the Broadwater Power Project include the debt service to retire the bonds used to finance the capital costs and the annual expenses for operation, maintenance, and other general expenses. General expenses include insurance coverage, the fee charged by FERC to administer the Federal Power Act, the cost of interim replacements and costs for administration and overhead. The Applicant is not subject to local, state, or federal taxes. As shown in Table D-2, the total annual cost is estimated to equal $3,050,000 in 1984, the first year of project operation.

Debt service comprises the major annual expense at $2,870,000. The estimate assumes that bonds were issued at an interest rate of 12 percent and amortized over 28 years, the time remaining on a 30-year bond following construction of the project.

Operation, maintenance and other expenses are estimated to total $175,000 in 1986. These costs are tied to salaries and thus will increase accordingly at a rate of 5 to 10 percent per year.

The annual cost of energy from the project is shown on Table D-2. Using the estimate of average annual energy produced at the site (see Exhibit B), the cost of energy in an average year is 54.0 mills/kWh. Note that more than 90 percent of the annual costs are fixed as debt service and will not escalate over time. The cost of energy, however, will

fluctuate from year to year as the streamflow available to produce power varies.

D.5 PROJECT ENERGY VALUE

No power purchase agreement has been negotiated for the Broadwater Power Project at present. Although some preliminary discussions have taken place, a full-scale effort to obtain an agreement will begin after this FERC license application is submitted.

The value of project energy is based on the avoided-cost rates that have been published for Montana utilities. The state has passed its own version of the Public Utility Regulatory Policies Act (PURPA) that specifies avoided-cost pricing for small power producers (69-3-601, et seq, Montana Administrative Code). In Montana, then, avoided-cost rates are expected to prevail regardless the outcome of pending judicial decisions that may affect PURPA.

Estimated prices for power from the Broadwater Project are shown in Table D-3. The prices are derived from energy rates and a capacity formula published by the Montana Public Service Commission and effective March 22, 1982. The capacity formula for each utility used an "Annual Contract Capacity Factor" in the calculation. This was interpreted as the average annual plant factor--64.4 percent for the Broadwater Project. The formula produced a dollar value per "annual contract kW" per month. This was interpreted as the installed capacity of the site.

The resulting capacity values for the project are $51,000 per month for Montana Power Company rates and $40,400 per month for the Montana-Dakota Utilities Company rates. To adequately compare the prices, the capacity values were translated into

mills per kWh by dividing the capacity value per month by the average kWh produced per month (4.7×10^6 kWh).

Projected avoided-cost prices to 1987 are presented in Table D-3. Projections beyond that time are subject to considerable uncertainty. Energy values were escalated at a rate of 5 percent per year over the five-year period. Capacity values were assumed to remain the same during that period. These assumptions lead to a conservative estimate of escalating prices. As Table D-3 indicates, the Broadwater Power Project is expected to be economical from its first year of operation--revenues will exceed costs. The Applicant believes that a power purchase agreement with Montana Power Company is most likely.

D.6 PROJECT FINANCING

The Applicant is a state agency in Montana and, therefore, could finance the project through tax-exempt bonds. These bonds carry a lower interest rate than regular bonds and offer the buyer tax-free income. The first step in the sale of revenue bonds is to obtain a power purchase agreement with a public utility or electric cooperative in Montana. Revenue bonds for the Broadwater Power Project are expected to carry a 12 percent interest rate and extend for 30 years.

TABLE D-1
BROADWATER POWER PROJECT

PROJECT CAPITAL COSTS
12 PERCENT INTEREST

February 1982 Price Level Escalated at
10 Percent Inflation Rate to Bid Date

FERC Account Number	Item	Cost* ($)
330	Land and Land Rights	$ 240,000
331	Structures and Improvements	2,950,000
332	Reservoirs, Dams, and Waterways	2,690,000
333	Turbines and Generators	4,930,000
334	Accessory Electrical Equipment	1,180,000
335	Miscellaneous Mechanical Equipment	158,000
355	Transmission Line and Improvements	80,000
	Direct Construction Cost	12,200,000
	Contingencies (15%)	1,830,000
	Subtotal	14,000,000
	Engineering Services at 15%	2,100,000
	Subtotal	16,100,000
	Administrative, Financial and Legal Costs at 3%	420,000
	Subtotal	16,500,000
	Interest During Construction (based on 12% interest rate, 24-month construction period)	2,360,000
	TOTAL PROJECT CAPITAL COST February 1982 Price Level	$18,900,000
	Escalation - February 1982 to Bid Date in February 1984 at 10% per year, compounded annually	4,000,000
	TOTAL PROJECT CAPITAL COST Escalated to February 1984	$22,900,000

* Rounded to three significant figures.

TABLE D-2
BROADWATER POWER PROJECT

PROJECT ANNUAL COSTS IN 1986
12 PERCENT INTEREST

Item	Annual Cost* ($)
Annual Debt Service (12% bonds, amortized for 28 years)	$2,870,000
Operation, Maintenance, and Interim Replacement	175,000
TOTAL ANNUAL COSTS	$3,050,000

Estimated Average Annual Energy Production $= 56{,}440{,}000$ kWh

Annual Cost of Energy $= \dfrac{3{,}050{,}000 \times 10^3 \text{ mills}}{56{,}440 \times 10^3 \text{ kWh}}$

$= 54.0$ mills/kWh

* Rounded to three significant figures.

TABLE D-3

ESTIMATED AVOIDED-COST PRICES
FOR POWER FROM THE BROADWATER PROJECT
(mills/kWh)

	Montana Power Company			Montana-Dakota Utilities Company		
Year	Energy	Capacity	Total	Energy	Capacity	Total
1982	40.9	10.9	51.8	45.8	8.6	54.4
1983	42.9	10.9	53.8	48.1	8.6	56.7
1984	45.0	10.9	55.9	50.5	8.6	59.1
1985	47.3	10.9	58.2	53.0	8.6	61.6
1986	49.7	10.9	60.6	55.7	8.6	64.6
1987	52.2	10.9	63.1	58.5	8.6	67.1

TABLE D-4

DETAILED COST ESTIMATE

BROADWATER POWER PROJECT

PRICE LEVEL--FEBRUARY 1982

Acct	Item	Unit	Quantity	Unit Price	Amount	Acct. Total
330	LAND AND LAND RIGHTS	LS				$240,000
331	STRUCTURES AND IMPROVEMENTS					
	Mobilization & Demobilization	LS			$132,800	
	Watercare & Diversion	LS			80,000	
	Concrete Removal	CY	350	$70.00	24,500	
	Common Excavation	CY	2,600	3.30	8,600	
	Rock Excavation	CY	4,500	30.00	135,000	
	Foundation Preparation	SF	6,600	2.00	13,200	
	Drains & Filters	LF	400	3.00	1,200	
	Concrete Anchors	LF	1,800	15.00	27,000	
	Grouting, Normal	CF	500	28.00	14,000	
	Grouting, Epoxy	CF	200	70.00	14,000	
	Concrete	CY	6,350	250.00	1,587,500	
	Reinforcement	LB	725,000	0.70	507,500	
	Miscellaneous Metal	LB	27,000	2.25	60,800	
	Hatches, etc.	LB	14,500	3.00	43,500	
	Waterproofing	SF	12,000	1.80	21,600	
	Backfill	CY	3,800	3.55	13,500	
	Disposal Fill	CY	3,650	1.35	4,900	
	Overhead Crane	LS			107,000	
	D/S Gantry Crane	LS			80,000	
	Miscellaneous Items	LS			71,400	
	TOTAL ACCOUNT 331					2,948,000

TABLE D-4

DETAILED COST ESTIMATE

BROADWATER POWER PROJECT

PRICE LEVEL--FEBRUARY 1982

Acct	Item	Unit	Quantity	Unit Price	Amount	Acct. Total
332	RESERVOIR, DAM AND WATERWAYS					
	Forebay Cleanup & Logboom	LS			67,000	
	Sluiceway, Remedial Work	LS			75,000	
	Tailrace Excavation, Rock	CY	1,200	30.00	36,000	
	Concrete, Training walls	CY	1,500	250.00	375,000	
	Reinforcement	LB	194,000	0.70	136,000	
	Grouting	CF	920	28.00	26,000	
	Riprap Protection	CY	400	30.00	12,000	
	Stoplogs (2 bays)	LS			27,000	
	Trashracks	LB	60,000	2.25	135,000	
	Trashrack Cleaner	LS			80,000	
	Radial Gates	LB	302,500	2.60	790,000	
	Vortex Suppressors	LS			54,000	
	Fixed Wheel Gates	LB	100,000	3.00	300,000	
	U/S Gantry Crane	LS			130,000	
	Watercare and Diversion	LS			70,000	
	Concrete Removal	CY	150	67.00	10,000	
	Crane Rails	LB	66,000	0.40	26,400	
	Concrete Anchors	LF	2,200	16.70	36,700	
	Switchyard Work	LS			40,000	
	Control Structure, Removal	LS			29,000	
	Excavation	CY	450	13.20	5,900	
	Control Structure Reconstruction	LS			93,000	
	Control Equipment	LS			20,000	
	Miscellaneous Metal	LB	6,500	2.25	14,600	
	Miscellaneous Items	LS			96,400	
	TOTAL ACCOUNT 332					2,685,000

TABLE D-4

DETAILED COST ESTIMATE

BROADWATER POWER PROJECT

PRICE LEVEL--FEBRUARY 1982

Acct	Item	Unit	Quantity	Unit Price	Amount	Acct. Total
333	WATERWHEELS, TURBINES & GENERATORS					
	Turbines & Governors	LS			3,100,000	
	Generators	LS			690,000	
	Speed Increasers	LS			678,000	
	Butterfly Valve		NR			
	Installation	LS			462,000	
	TOTAL ACCOUNT 333					4,930,000
334	ACCESSORY ELECTRICAL EQUIPMENT					
	Transformer, Circuit Breaker, Switchgear, etc.	LS			293,000	
	Station Electrical Equipment	LS			784,000	
	Additional Breakers	LS			103,000	
	TOTAL ACCOUNT 334					1,180,000
335	MISCELLANEOUS POWER PLANT EQUIPMENT	LS				158,000
355	TRANSMISSION LINE (one mile)	LS				80,000
GRAND TOTAL ALL ACCOUNTS						$12,220,000

EXHIBIT E

ENVIRONMENTAL REPORT

TABLE OF CONTENTS

TABLES

MAPS

FIGURES

EXHIBIT E

An Environmental Report

E.1 GENERAL DESCRIPTION OF THE PROJECT AREA.

Broadwater Dam spans the Missouri River approximately 34 Km (21 mi) downstream from where the confluence of the Madison, Gallatin, and Jefferson rivers forms the mainstem. The dam lies in a narrow steep-walled canyon between the Clarkston and Townsend Valleys.

The existing structure is 215 m (705 ft) long and 12 m (40 ft) high from foundation to spillway crest. It was built in 1940 to provide irrigation water.

The river channel immediately upstream from the dam is a horseshoe bend approximately eight km (five mi) long, with the canyon walls rising almost vertically from near the water's edge in some places. At its normal operating elevation of approximately 1,204 m (3,951 ft), the reservoir has a surface of 127 hectares (313 acres). Over a normal year, the surface level varies from approximately 1,202 m (3,943 ft) to 1,205 m (3,953 ft), above mean sea level.

The narrowness of the canyon limits the floodplain to a thin strip and restricts riparian vegetation to a fringe bordering the riverbanks and several islands in the reservoir. Vegetation on the surrounding hills is adapted

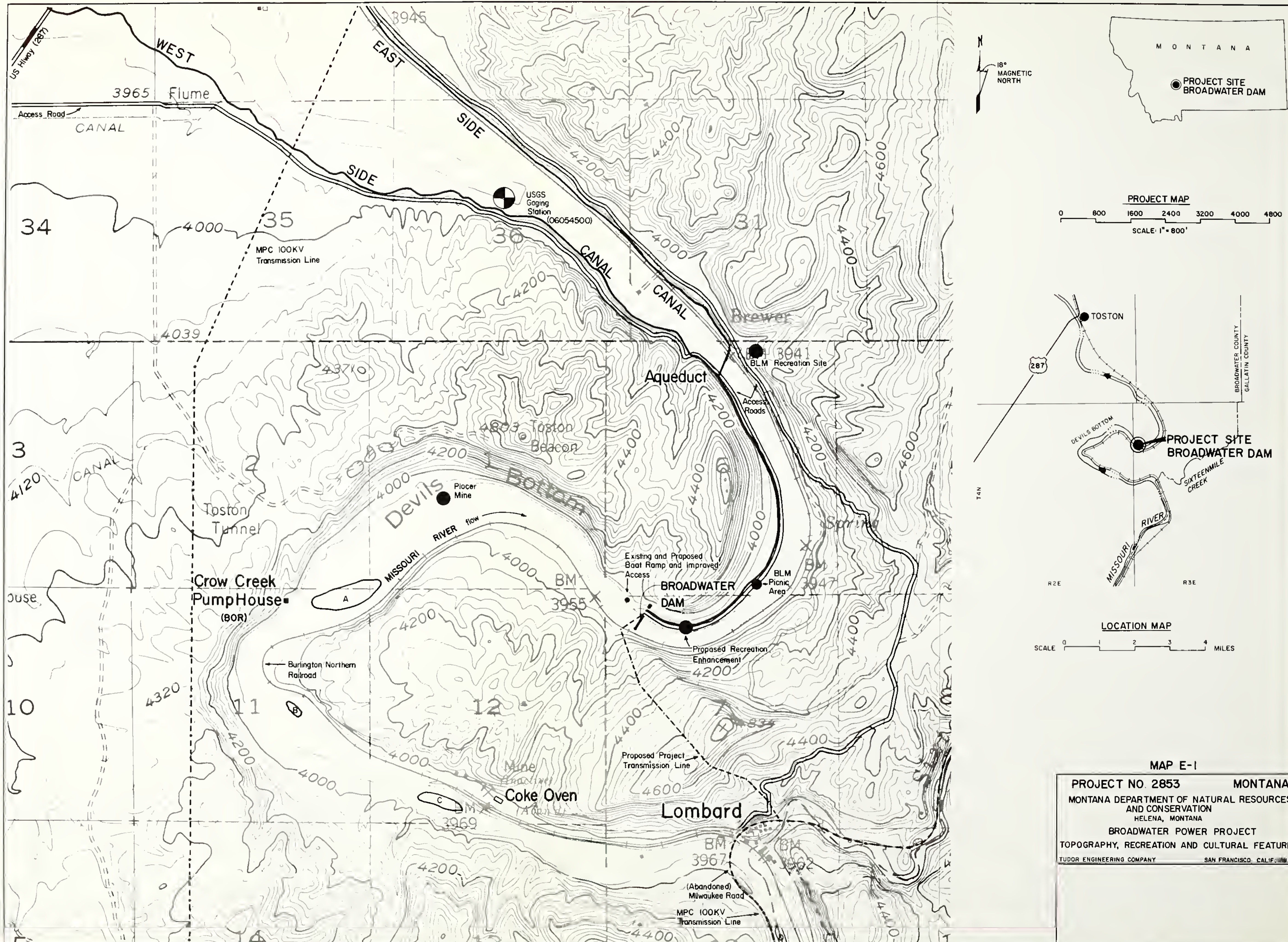
to the prevailing dry conditions, with a sparse growth of grasses, shrubs, and scattered trees.

Precipitation averages 25 to 30 cm (10 to 12 in) a year. The prevailing winds are westerly.

The terrain east of the reservoir is dominated by many square miles of rugged and nearly uninhabited territory. Immediately west of the reservoir is an abrupt ridge, rising several hundred feet above the level of the reservoir. From its crest, this ridge slopes west to an extensive area of irrigated farm land (see Map E-1).

At the upper end of the reservoir, approximately eight km (five mi) above the dam, Sixteenmile Creek enters the Missouri near the abandoned townsite of Lombard. Two railroads, the Burlington Northern and the now abandoned Milwaukee Road pass the site of Lombard. Both approach from the south along the Missouri, with the Burlington Northern on the east side of the river and the Milwaukee Road on the west. At Lombard, the Milwaukee crosses the river on a trestle and continues east up Sixteenmile Creek. The Burlington Northern tracks continue along the reservoir past the dam. On a normal day, 14 trains pass the dam.

A primitive road crosses the steep ridge east of the river to Lombard. A road over the ridge on the west side leads to an irrigation pump station 2.9 km (1.8 mi) upstream from the dam. A gravel access road parallels the river to the mouth of the canyon and then continues west to an intersection with U.S. Highway 287 approximately 2.4 km



MAP E-1

PROJECT NO. 2853 MONTANA

MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION
HELENA, MONTANA

BROADWATER POWER PROJECT

TOPOGRAPHY, RECREATION AND CULTURAL FEATURES

TUDOR ENGINEERING COMPANY SAN FRANCISCO, CALIF.

(1.5 miles) south of Toston and 8.0 km (5 miles) from the dam. These are the only roads in the reservoir area.

There are no permanent dwellings along the reservoir, but one man lives on a sporadic basis in a trailer at the placer gold mining operation he works on the west (left) side of the reservoir about 1.6 km (1 mi) above the dam.

Irrigation water moves from the reservoir through two outlets. The first is a canal that leaves the reservoir just upstream from the dam on the left bank. It proceeds along a terrace above the Missouri for approximately 2.4 km (1.5 mi), and then branches into two smaller canals. One of which connects with a pipe across the Missouri to another canal that takes water down the east side of the river. These canals supply numerous farms in the Toston-Townsend area. In 1980 water from these canals irrigated approximately 6,073 hectares (15,000 acres). The second outlet is the pump station above the dam, which supplies water from the reservoir to approximately 2,024 hectares (5,000 acres) to the west.

The reservoir area provides habitat for a wide variety of wildlife, including beaver, muskrat, raccoon, mink, otter, white-tailed deer, ducks, geese, and shorebirds.

Mule and white-tailed deer and elk are among the species that use the river and hills above and below the dam. In winter, bald eagles congregate along the open water below the dam (Elliott 1980). There is a golden

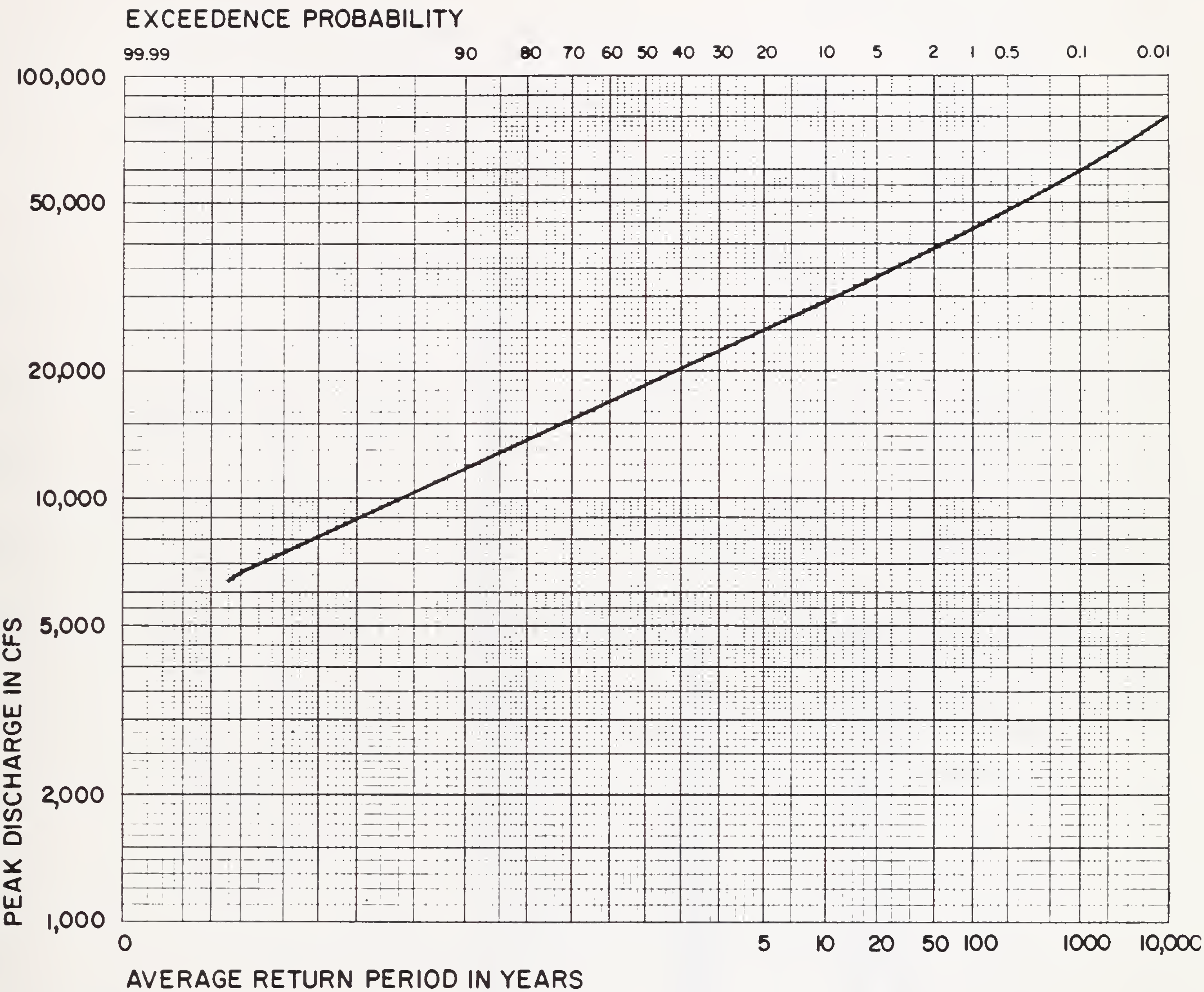
eagle nest in rugged terrain just downstream from the dam, and prairie falcons nest in the same vicinity.

The trout fishery in the Missouri below the dam is highly productive, and many large trout are taken between the dam and Canyon Ferry Reservoir, 34 km (21 mi) downstream.

Canyon Ferry Reservoir is one of the most heavily fished impoundments in Montana. The Department of Fish Wildlife and Parks (DFWP) maintains the recreational fishery in Canyon Ferry with an annual plant of 650,000 juvenile rainbow trout, at a cost of $25,000. These trout are a domestic strain which characteristically survives poorly in the wild and does not reproduce. Broadwater Reservoir is dominated by nongame fish.

The annual peak flow frequency curve (Figure E-1) for the site was developed using the instantaneous peak flow records from the U.S. Geological Survey. This figure shows the statistical return interval for peak flows of specified magnitude.

The probable maximum flood (PMF) at the Broadwater project is estimated at 4,050 cubic meters per second (cms) (143,000 cubic feet second). The maximum flood that could pass the dam without overtopping the retaining wall sections at the dam abutments is estimated to be 2,158 cms (76,200 cfs) (Tudor Engineering 1979). This corresponds to a recurrence interval of about 10,000 years. Corps of Engineers criteria recommend that dams such as Broadwater,



PEAK FLOW FREQUENCY CURVE

FIGURE
E-1

where dam failure would not endanger human life, be capable of passing one-half the PMF, which is approximately 2,039 cms (72,000 cfs) in this case. This is less than the estimated flood passing capability of the dam, indicating the dam is adequate for flood passage.

There has been no administrative delineation of flood plain boundaries on this portion of the Missouri.

A ten-year hydrograph of monthly high, mean, and low flows for the Missouri River at Toston is shown in Figure E-2, as requested by the U.S. Fish and Wildlife Service (Ballou 1979).

E.2 WATER USE AND QUALITY

E.2.1 Existing and Proposed Water Uses

The Broadwater Dam and canal system were built to divert water from the Missouri River for irrigation. Water is diverted at the dam through a 12 cms (423 cfs) capacity canal to supply irrigation water to 8,094 hactares (20,000 acres). The total withdrawal of 143.02 cubic hectometers (116,000 acre-feet) occurs over a period ranging from April to October each year. The reservoir created by the dam stores approximately 4.25 cubic hectometers (3447 AF).

Water is also withdrawn from the river via the Bureau of Reclamation's (BOR) Crow Creek pump station, located approximately 2.9 km (1.8 mi.) upstream from the dam on the left bank of the river. There are no current data for the

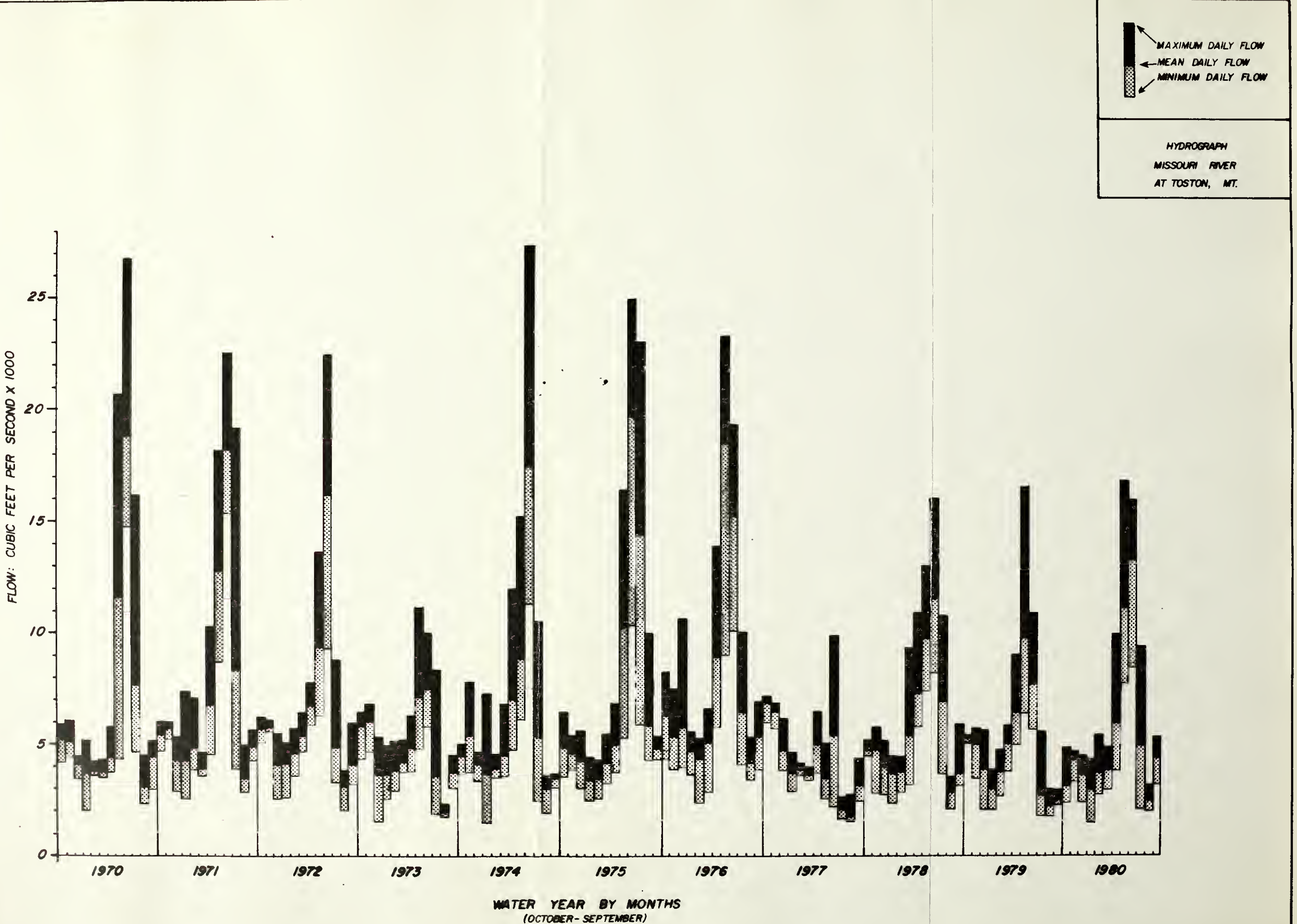


FIGURE: E-2 Minimum, mean and Maximum Daily Flows for Water Years 1970-1980

amount of water pumped to the Toston Irrigation District water users, but 24.6 cubic hectometers (19,938.70 AF) of water were diverted in 1978. The U.S. government owns rights to approximately 88.8 cubic hectometers (72,000 AF) at the Crow Creek pump station.

DNRC has submitted a water right application, #16825, requesting 268.8 cms (9,500 cfs) up to 8,513.1 cubic hectometers (6,900,000 AF) of water per year to operate the proposed hydropower facility at Broadwater Dam. The application has been amended to request 203.8 cms (7,200 cfs) up to 6,484.8 cubic hectometers (5,216,000 AF) which represents the maximum capacity of the four turbine unit that is presently planned. The initial application included water for two additional turbines which may be added in the future.

Since the proposed facility will operated as a run-of-the-river plant (e.g. the facility will use whatever water is flowing in the channel up to the maximum capacity of the turbines and spill the remainder) it will not have any effect on senior appropriators. The proposed water use is nonconsumptive so river flows, both upstream and downstream will be unchanged. Existing irrigation would not be affected by the project, and would remain the only consumptive use of the water associated with the dam.

E.2.2 Existing Water Quality

Water quality in the Missouri River at the Broadwater Dam is generally good, according to the Montana Department

of Health and Environmental Sciences (MDHES). Although the headwaters receive wastes from municipal, industrial, and agricultural activities, the combined effects of point source treatment and natural river self purification have so far minimized water quality impacts. This high water quality is apparent in the excellent salmonid fishery in the headwater tributaries and Missouri mainstem. With sound management, water quality should remain high (MDHES 1980).

The major chemical, physical, and biological indicators of water quality in the Missouri River at Toston are listed in Table E-1. This table summarizes data collected at the Toston U.S.G.S. water monitoring station approximately 4.8 km (three mi) downstream from the dam. The data in Table E-1 show the river samples were typically a hard, calcium bicarbonate water with lesser concentrations of magnesium, sodium, sulfate and chloride ions. The moderate arsenic and fluoride content in the river comes from thermal springs in Yellowstone National Park. The low 5-day biochemical oxygen demand (BOD(5)), low mean fecal coliform counts, low-to-medium nutrient (phosphorus and nitrogen) content, and the high dissolved oxygen levels indicate little residual effect from upstream contamination. Trace quantities of heavy metals and organic pesticides also are found in the river water.

The Missouri River above and below Broadwater Dam is classified B-1 under the Montana Water Use Classification System as recently updated in the Montana Administrative Code. Water in this classification is suitable for

Table E-1 Selected Water Quality Parameters for Missouri River at Toston, MT

Item	Units	Number of Samples	Mean	Standard Deviation	Maximum Value	Minimum Value
Water temp.	^{o}C	170	11.7	7.0	22.5	0.0
Turbidity	F.T.U.	28	5.8	5.6	19.0	.1
Conductivity @25^{o}c	Micromho	150	367.8	475.0	205.0	55.4
Dissolved O_2	mg/l O_2	149	10.3	1.7	13.8	8.0
Dissolved O_2 staturation		136	106.6	7.3	124.0	90.0
pH	SU	144	8.3	.3	8.8	7.3
BOD_5	mg/l	17	2.0	.7	3.7	1.1
Total organic Carbon	mg/l C	41	4.5	2.8	16.0	1.4
Periphyton (Dry)	gr/m^2	11	18.4	23.8	66.0	.1
Total Nitrogen	mg/l N	88	.6	.3	2.0	.2
Total org. Nitrogen	mg/l N	31	.5	.3	1.1	.2
Total NH_3+NH_4	mg/l N	36	.03	.03	.11	0
Total phosphate	mg/l P	94	.06	.06	.44	0.0
Carbon Dioxide	mg/l $CaCO_3$	64	4.6	3.9	20.9	1.1
Total Alkalinity	mg/l $CaCO_3$	109	135	21.1	170	75
HCO_3^-	mg/l $CaCO_3$	65	135	20.2	161.0	80.0
CO_3^{-2}	mg/l $CaCO_3$	55	1.5	3.2	11.7	0
Total Hardness	mg/l $CaCO_3$	98	144	25.3	190	76
Noncarbonate Hardness	mg/l $CaCO_3$	92	9.9	7.1	23	0
Calcium (dissolved)	mg/l $CaCO_3$	98	96	16.8	125	35
Magnesium (dissolved)	mg/l $CaCO_3$	98	47.8	9.2	65.6	24.6
Sodium	mg/l Na	98	19.7	4.5	30.0	8.2
Potassium	mg/l K	92	3.8	.6	5.4	1.8
Chloride	mg/l Cl^-	99	10.6	3.2	18.0	3.5
Sulfate	mg/l SO_4^{-2}	99	38.6	9.0	54.0	15.0
Fluoride	mg/l F^-	99	1.0	.32	1.9	.4
Arsenic	mg/l As	32	26.1	10.6	55	11
Total Coliform	Org/100ml	20	289	835	3800	10
Fecal Coliform	Org/100ml	51	62	165	1100	2
Fecal Strep.	Org/100ml	82	83	295	2600	0

drinking, culinary and food processing purposes after conventional treatment; bathing, swimming and recreation; growth and propagation of salmonid fishes and associated aquatic life, waterfowl and furbearers; and agricultural and industrial water supply. Table E-2 lists the specific water quality standards which cannot be violated for water in this classification.

E.2.3 Minimum Flow Releases and Recommended Measures for Maintaining Water Quality

As noted, the existing Broadwater Dam would remain a run-of-the-river diversion dam with little storage. As such, the dam lacks the capacity that would make minimum flows a significant consideration.

The agencies consulted did not recommend any measures for the preservation of water quality.

E.2.4 Measures to Protect Water Quality

Construction and operation of the proposed facility could affect water quality.

Construction would require use of heavy equipment, dewatering of work sites, earthwork in the river bed and on the left bank, and concrete mixing and pouring. If not managed properly, such activities can cause increased turbidity, contamination by petroleum products, and degradation of sanitary conditions from increased human activity. Some of these potential impacts would be readily

Table E-2 Water Quality Requirements for B-1 Classified Waters

Parameter	Requirement
Fecal coliform	Geometric mean <200 org/100ml with no more than 10% of samples > 400 org/100ml in any 30-day period.
D.O.	Must remain > 7.0 mg/l
pH	Natural pH 6.5 - 8.5; Induced variation <.5 pH units Natural pH other than 6.5 - 8.5; no change allowed Natural pH >7.0; must remain >7.0
Turbidity	Max increase above natural levels is 5 FTU.*
Temperature	Naturally occurring water temp 32°F-66°F; 1° maximum increase " " 66°F-66.5°F; no change >67°F " " >66.5°F; .5°F maximum increase " " >55°F; maximum 2°F decrease per hour " " 55°F-32°F; maximum 2°F decrease
Sediment	No increase over natural level which is nuisance, harmful, detrimental or injurious to public health or designated uses.
Solids, oils floating solids	Same as sediment
Color	Maximum true color increase <5 color units
Toxic or deleterious substances	Water must meet National primary and secondary drinking water standards after conventional treatment.

* Permitted exceptions to turbidity standards listed in ARM 16.20.631 through 16.20.635 and ARM 16.20.641 and ARM 16.20.642.

controlled. Sanitary degradation would be averted by installing and requiring the use of portable closed-vault restroom facilities. Petroleum contamination would be avoided by requiring contractors to establish an equipment and petroleum storage area with measures to prevent direct drainage to the river or canal. Contractors would be required to remove and properly dispose of petroleum contaminated soils after construction, and to pay for clean-up of avoidable petroleum contamination. Turbidity increases lasting up to a few days would be more difficult to avoid. The use of sheet pile coffer dams instead of earth and rock fill where possible would alleviate the problem. Turbidity from runoff and seepage in dewatered areas would be controlled with a simple sediment trap system. Runoff and seepage would be routed through a system of collector ditches and a sediment trap, consisting of staked straw bales. The straw would trap sediments and absorb waste petroleum products from the runoff, and would be replaced as necessary. There is not enough room at the site for settling ponds, which ordinarily would be one of the options for pollution control.

Hydroelectric operation at Broadwater Dam probably would not affect water quality. The turbine system does not require injected air for cavitation protection and the low head of 6.7 meters (22 ft) would preclude deep spillway plunge pools. Therefore, gas supersaturation does not appear to be a potential problem. Raising the height of the flood pool would inundate approximately four hectares (10 acres) of land. Nutrient increases due to leaching from inundated areas would be minor.

The proposed addition to Broadwater Dam could have a minor effect on the movement of sediment through the project area. The additional .49 m (1.6 ft) in pool elevation would increase water residence time an average of approximately one hour, which would allow more of the finer-grained sediments to settle. A negligible reduction in natural turbidity below the dam could result. Furthermore, maintaining the pool at a relatively constant year-round elevation would eliminate sediment flushing that occurs when the pool is lowered in the fall. This could result in a slight increase of the sedimentation rate in the backwater. Construction of sanitation facilities at the proposed facility would eliminate the potential for sanitary impacts on the river.

E.2.5 Continuing Water Quality Impacts

No long-term water quality changes would be expected to result from operation of the proposed project, except for the possible slight decrease in downstream turbidity.

E.2.6 Water Quality Certificate.

The letter requesting a Water Quality Certificate and the response of the Department of Health and Environmental Sciences is located in Appendix E-2.

E.3 FISH, WILDLIFE AND BOTANICAL RESOURCES

E.3.1 Description of Fish, Wildlife, and Botanical Resources

(A) Fish Resources

The 34-km (21-mi) section of the Missouri between Broadwater Dam and Canyon Ferry Reservoir is a nationally acclaimed recreational fishery ranked by the Montana Department of Fish, Wildlife and Parks (1980) as class I (highest value fishery resource). The fishery here is particularly good during the fall spawning run of brown trout from Canyon Ferry Reservoir. Many of these fish are in the 2.3 to 4.5 kg (5 to 10 lb) class. These migrants apparently congregate below Broadwater Dam, where they are caught in substantial numbers.

Broadwater Reservoir is a small run-of-the-river-reservoir with a habitat type between that of a lake and a river. Such habitats are not conducive to trout production and the reservoir is dominated by nongame fish.

(B) Wildlife Resources

DNRC field researchers determined that many semi-aquatic mammals, especially river otter, mink, beaver, and muskrat, use the riparian zone around the reservoir. Striped skunk, raccoon, and white-tailed deer also occur in this zone, which provides relatively high security cover and an abundant food supply. River otters concentrate in the pool area and just below the dam (Yannone 1980). DNRC researchers saw groups of up to four otters near Island Group B (see map E-1) during the fall 1980 study. When the pool was drawn down to 2.1 m (seven ft) below the normal operating level in November, 1980, the exposed mud bars

were heavily covered with the tracks of beaver, raccoon, mink, and striped skunk.

Mule deer inhabit the project area year-round but are more abundant in winter. They favor south-facing mountain mahogany-dominated slopes which provide both abundant browse and cover. White-tail deer prefer brushy islands and cottonwood-shrub habitats. Up to 300 elk winter in the Lombard-Sixteenmile Creek area (north of Sixteen Mile Creek and east of the dam), where they graze steep, wind-swept bluebunch wheatgrass slopes near timbered draws (Elliott 1980).

Bald eagles concentrate in winter along the ice-free stretch of river 1.6 - 3.2 km (1-2 mi) below the dam which often is one of the few areas of open water. This area is considered "crucial" habitat by the Bureau of Land Management (BLM) and is being considered for recommendation to the U.S. Fish and Wildlife Service as "essential" bald eagle habitat (Appendix E-2). Wintering eagles subsist on fish and crippled waterfowl in this area (Elliot 1980). No bald eagle nests are known to exist in the area. There is a recently active golden eagle nest in section 6, T4N, R3E, below the dam, and prairie falcons are known to nest in the same vicinity (Yannone 1980). Waterfowl use the project area heavily during spring and fall migrations, and for nesting. The reservoir is frozen from December through February and therefore is not used in winter. Common mergansers are the most frequently observed waterfowl species year-round. Canada geese use the nesting sites provided by the river islands. An April 1980 survey

between Toston and Clarkston recorded 43 geese (15 pairs, 10 singles, and three broods)(Herbert 1980). The cattail and bulrush-willow marshes in the pool area offer excellent mallard brood-rearing habitat, although there are no data on actual use. Use may be limited by the lack of submerged areas less than 2.1 meters (seven feet) below the water surface. The riparian habitats probably are used as breeding habitat by many other birds, especially grebes and shorebirds. Cavities in the snags found on Island Group B provide nesting habitat for tree swallows, common flickers, and other cavity-nesting birds.

(C) Botanical Resources

The project area is located in a generally dry region with average annual precipitation between 25 and 30 cm (10 and 12 in) per year. Riparian vegetation, including both emergent vegetation (plants with their lower portions underwater at least part of the year) and other vegetation influenced by a high water table, is confined to a narrow fringe along the riverbanks and on a few islands. The steep-walled canyon prevents the forming of the broad floodplains characteristic of many other Missouri River stretches. In general, riparian vegetation exists only in a zone below or slightly above normal operating elevation.

Cattail, bulrush, sedge, common reedgrass, canary reedgrass, other grasses, and willow dominate this zone. Upland habitat types include dry grasslands and shrublands dominated by blue grama, needle-and-thread grass, bluebunch wheatgrass, big sagebrush, Rocky Mountain juniper, mountain

mahogany, and skunkbrush sumac. Douglas fir and limber pine are found in a few restricted sites.

Vegetation along the powerline route includes blue grama grass, needle-and-thread grass, wheatgrass, big sagebrush, rubber rabbitbrush, yucca, Rocky Mountain juniper, skunkbrush sumac, scattered limber pine and mountain mahogany. There are several young stands of cottonwoods near the upper end of the pool.

E.3.2 Mitigating Measures and Facilities Recommended by Other Agencies

BLM recommended that the cottonwood trees downstream from the dam be preserved, and that the spawning ground just below the dam be maintained as it is. BLM also recommended that a fish ladder be included in the project. In conjunction with the proposed project, the DFWP would do a study of whether a fish ladder would be desirable or feasible (see Appendix E-1).

E.3.3 Existing and Proposed Mitigating Measures

The DFWP study (see Appendix E-1) and mitigation recommended as a result of that study will be funded by DNRC and mitigation recommended will be implemented.

DNRC will not inhibit the implementation of any of the recommendations resulting from BLM's land use survey and will work cooperatively with the agency where possible. No trees would be destroyed except for those growing where the

substation would be located. Construction and operation of the project would not be expected to affect spawning gravel below the dam.

E.3.4 Continuing Impacts of the Project

(A) Fishery Impacts

The major issue related to fishery impacts at the proposed project is whether a fish ladder should be included.

DFWP has not determined whether it would require a fish ladder at the proposed facility. Such a ladder could conceivably have major effects on the fisheries of the upper Missouri River system. To actually weigh the relative importance of the fish ladder arguments would require additional study by the DFWP. A study proposal designed by the DFWP to answer some of the questions is included in Appendix E-1. The following discussion raises the issues that have to be considered in deciding whether the ladder should be built.

There would be few serious long-term adverse effects on aquatic habitats if the project were constructed without a fish ladder. The projected .49 m (1.6 ft) increase and stabilization of water levels would increase the overall habitat available to aquatic organisms.

If a fish ladder were to be included, it could greatly increase the spawning habitat available to migrant trout

from Canyon Ferry Reservoir. The ladder hypothetically would provide access to well over 800 km (500 mi) of tributary rivers and streams. The spawning and rearing areas below Broadwater Dam may be inadequate for the existing migrant trout population and consequently may not be providing sufficient reproduction for the reservoir trout fishery. Access to favorable spawning and nursing areas above the dam might therefore be desirable. More reproduction could increase adult trout numbers in Canyon Ferry Reservoir which would provide more large fish between Broadwater Dam and Canyon Ferry Reservoir during the spring and fall spawning periods. The presence of these large migrants in the mainstem and headwater rivers upstream of Broadwater Dam could improve the quality of the fisheries there during the migration period. Furthermore, the added reproduction could eliminate the need to plant Canyon Ferry Reservoir with hatchery trout.

In the future, DFWP may choose to establish a reproducing, self-sustaining population by planting a wild strain rainbow trout or salmon in Canyon Ferry. The recreational fishery in two southwest Montana reservoirs (Hyalite and Harrison) improved dramatically after they were experimentally planted with wild trout stocks. This switch to wild stocks may become department policy when an adequate source of stocks becomes available. Such a policy would require the passage of fish over Broadwater Dam if spawning areas below the dam proved inadequate.

A fish ladder also would relieve fishing pressure by eliminating the concentrated and vulnerable trout

population that congregates below Broadwater Dam. A reduction of the fish concentrations below the dam might reduce the impact of anglers on the migrant population and create a higher quality recreational experience by spreading the migrant population over a greater expanse of fishable water.

Installation of the fish ladder also could have drawbacks. For example, the existing dam is effective in preventing spawning migrations of undesirable species, such as common and longnose suckers, from entering the river systems upstream from the dam where they might harm resident trout populations. The existing dam also prevents brown and rainbow trout residing in Canyon Ferry Reservoir from entering the upstream river systems and competing with the resident trout for spawning and rearing areas. This competition could adversely affect the resident populations, which currently provide a quality year-round recreational fishery. The dam also prevents the spread of unwanted exotic fish species into the upper Missouri system. There currently are no undesirable species on one side of the dam that are not also present on the other side, but species such as northern pike could be introduced into Canyon Ferry Reservoir by well-meaning but uninformed fishermen.

There is no assurance that a ladder would pass a significant portion of the trout that congregate below the dam. Although proper design and operational criteria enhance the chance of successful fish passage, fish sometimes will not use such facilities. Establishing a

migratory population that would use the Missouri drainage above Broadwater Dam could be a difficult management problem. Likewise, there is no assurance that the ladder would successfully pass spent spawners returning to Canyon Ferry. Most fish would drift with the flow through the turbines where they could be killed.

Furthermore, for the ladder to be successful, juveniles reared upstream would have to pass the dam on their downstream migrations to Canyon Ferry Reservoir. It is not known what portion of these would be killed in the turbines, but mortality could range up to 100 percent, depending in part on the turbine and intake design. Fish survival is highest when (1) runner speed is low, (2) draft tube pressure is high, (3) clearances between runner blades are high, and (4) the turbine is operating at peak efficiency. Predictions on the potential survival rate of small fish at the proposed project can only be made when further information on the proposed design becomes available. Most large fish moving downstream probably would be killed no matter what turbine design was used.

It is not yet possible to determine whether a fish ladder should be constructed. This decision would be made following completion of DFWP's study of the effects of such a ladder. DNRC would provide funding for the study (see Appendix E-1). This study would not be completed in time for this application. Therefore, the dam would be designed so that a fish ladder could be added if it were determined to be desirable. DNRC also would consider installation of a turbine bypass system for the dam in the event that turbine

mortalities substantially offset the benefits of the ladder or harmed the downstream fisheries.

Excavation and placement of coffer dams would not be done in the fall when high turbidities would impair brown trout spawning.

(B) Wildlife Impacts

The altering of riparian habitat would have little effect on wildlife, and probably would cause no significant changes in carrying capacity for white-tailed deer or semi-aquatic mammals. The likely development of submerged aquatic plants in the inundated area could increase the suitability of restored marsh habitats for duck breeding. However, the riverine marsh habitat, including some cattail islands, would be substantially reduced, which could reduce the waterbird population now using the area. It is not currently known whether Island Groups B, and C are used for goose nesting, but the increased pool level probably would destroy whatever habitat is there (see map E-2). The suitability of Island D for goose nesting would not be greatly reduced by the project. The loss of the cattail marsh habitat in Island Group B would be partly offset when the increased pool level created of similar cattail island marshes on the floodplain approximately .8 km (.5 mi) downstream from Lombard. More exact information on these potential impacts would be contained in the study proposed by DFWP (see Appendix E-1).

Likely sources of wildlife disturbance from the project are: (1) the presence of up to 30 construction workers in the project area; (2) construction activity at the dam; (3) blasting and heavy equipment operation during excavation; and (4) noise created by transport and unloading of excavated material and by the concrete batching operation. There are no estimates of project noise levels. Noise levels already are fairly high in the project area because of the 14 railroad trains that pass daily along the river, and the roar of water over the spillway.

The wildlife species most sensitive to construction noise and human activity are waterfowl, large raptors (particularly bald eagles, golden eagles, and prairie falcons), and wintering elk. Waterfowl probably would avoid the dam during active construction. Wintering bald eagles are very sensitive to human activity (Craighead and Craighead 1979, Meyer 1979), but probably would not be adversely affected by the project, as the ice-free stretch of river they use extends a mile or more downstream from the dam. The elk that winter in the project area are not likely to be displaced from their winter range by construction noise, and the golden eagle and prairie falcon nests are located far enough from the project to minimize the likelihood of nest abandonment.

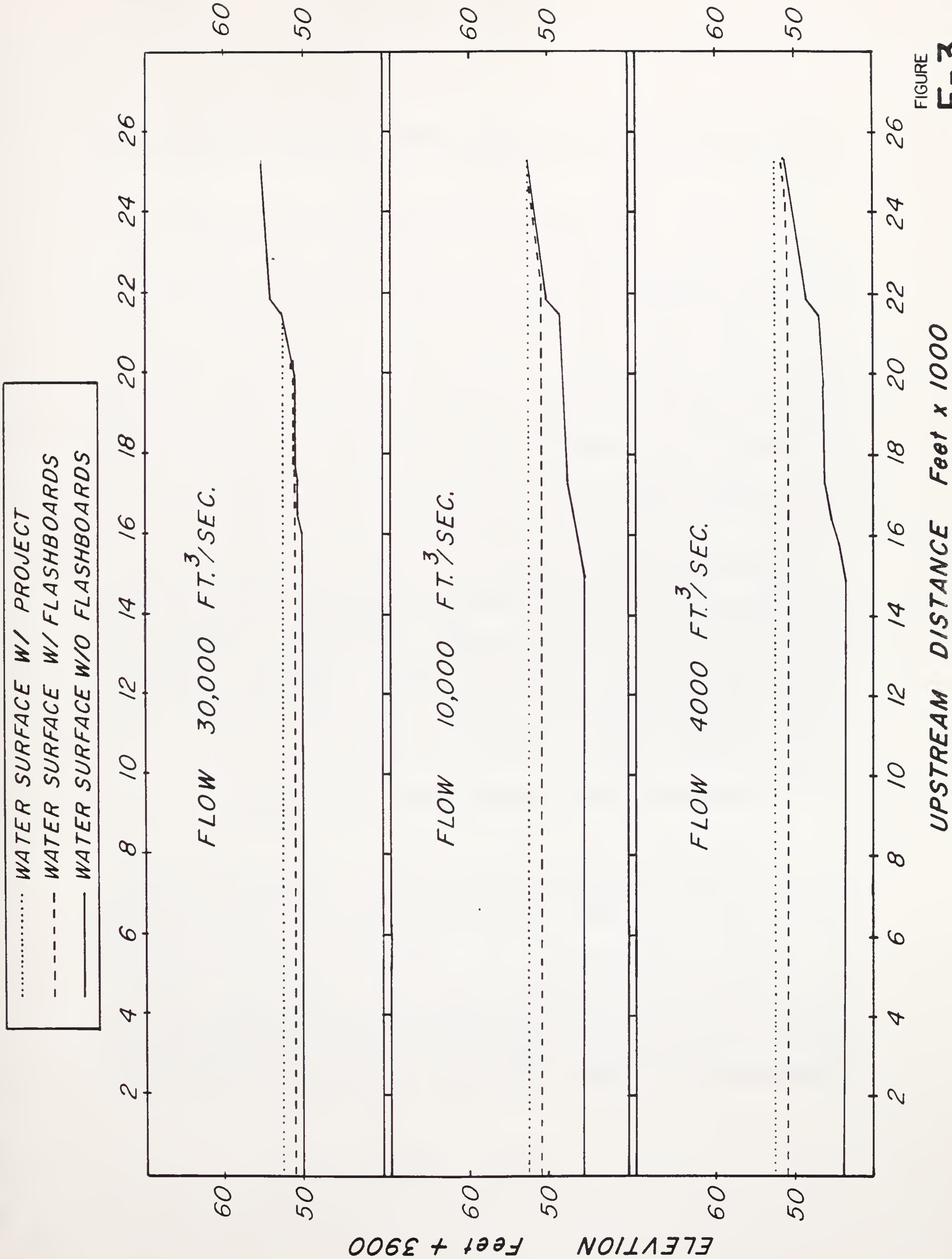
(C) Botanical Impacts

Operation of Broadwater Dam has had a significant effect on the vegetation in the pool area. This effect

would change under the operation of the proposed project. Water levels would be maintained year round roughly .49 m (1.6 ft) above the present normal operating elevation, and the winter drawdown would be eliminated. Figure E-3 indicates that water levels would be raised .49 m (1.6 ft) for a distance of roughly 7.2 river km (4.5 river mi) upstream from the dam assuming a river flow of 283 cms (10,000 cfs). Normal operating elevation is currently maintained only during the irrigation season, but the hydroelectric project would hold the higher pool levels almost constant year-round.

It appears that approximately four hectares (10 acres) of land would be inundated and the emergent vegetation growing .43 m (1.4 ft) or more below the current normal operating elevation would be lost. This would include much of the cattail marsh at the head of the dam and near Island Group B. The riparian vegetation zones would shift upward, where topography allowed.

Maintaining the pool at a constant level would kill some vegetation that currently is partially submerged part of the year and above water the rest of the year. Many plants such as willow can tolerate immersion for six months but not year-round. Also, existing emergent vegetation is not scoured by shoreline ice in winter and spring because of the lower water levels at those times. With a stable year-round pool level, there might be some ice scouring of emergent vegetation. This scouring probably would tend to raise the elevation of the emergent vegetation. A constant water level would encourage growth of submerged aquatic



WATER SURFACE W/ PROJECT
WATER SURFACE W/ FLASHBOARDS
WATER SURFACE W/O FLASHBOARDS
FLOW 30,000 FT.^{3}/SEC.
FLOW 10,000 FT.^{3}/SEC.
FLOW 4000 FT.^{3}/SEC.
60
50
2
4
6
8
10
12
14
16
18
20
22
24
26
ELEVATION Feet + 3900
UPSTREAM DISTANCE Feet x 1000

FIGURE E-3

plants, which currently are absent from the zone 2.1 m (seven ft) below normal operating elevation.

The lack of extensive floodplains in the project area reduces the opportunity for development of new marsh habitats similar to those near Island Group B. The most likely sites for establishment of new marsh habitats are along the lower end of Devil's Bottom; along the beach at the river bend just above Island Group B, the railroad borrow pits, and along the floodplains on the left bank just below the Lombard Bridge. The willow-dogwood-cottonwood community on the latter floodplain would be partly replaced by cattail marsh or other emergents.

Island Groups B and C would be greatly reduced in size, and the present willow-dominated communities probably would be replaced by a few patches of cattail. The portion affected on Island D probably would support a willow-cattail community where willows now grow alone. This island would be little reduced in size.

E.3.5 Specifications on Measures and Facilities

If the DFWP study were to determine that a fish ladder and return passage were desirable, and if DFWP required construction of such facilities, DNRC would cooperate in (1) design of the facility, (2) development of operation and maintenance procedures for the facilities, and (3) scheduling the construction and implementation of the facilities and their operation. DNRC would fund these items plus construction. A map and drawings of the fish

ladder would be furnished when its design had been determined.

E.4 HISTORICAL AND ARCHAEOLOGICAL RESOURCES

E.4.1 Sites Eligible for the National Register of Historic Places

DNRC located several cultural resource sites that could be affected by the project, two of which are recommended for inclusion in the National Register of Historic Places.

The first of these is site 24BW182, a partially buried prehistoric campsite on an alluvial fan and river terrace on the left shore about 3.2 km (two mi) upstream from Broadwater Dam. Reservoir erosion is causing bank collapse and slumpage which has left the site exposed in the riverbank. A portion of the site already has eroded into the reservoir. Assorted prehistoric cultural materials, including stone flakes and tools, bone scrap, and several fire hearths are visible in several poorly defined strata in the riverbank, and on the surface of the terrace and the reservoir beach.

DNRC archaeologists' tests indicated the site meets the criteria for the National Register of Historic Places and should be listed.

The second site recommended for inclusion in the register is 24BW180, a post-1900 coke oven structure with an associated coal mine, slag piles, and mining/processing

appurtenances (see map E-1). Built of brick and native stone, the coke oven structure contains twelve igloo-shaped kilns interconnected within a stone wall measuring approximately 61 m (200 ft) long. Each kiln is brick lined, 2.1 m (seven ft) high, with a smoke hole in the roof and a waist-high iron-framed door.

Another prehistoric hearth site, 24BW570, was found by a researcher in 1974. It was said to be located approximately 2.4 km (1.5 mi) above the dam on the left bank, but the site description in the historical file was brief, and did not provide enough information to lead DNRC archaeologists to the site. This hearth may have been covered by silt or eroded into the reservoir. If these or other buried cultural remains were to be exposed by construction or changes in the reservoir level, they would be investigated to determine whether mitigating measures were necessary.

Site 24BW181 is a single tipi ring located on a sage-covered alluvial fan approximately 50 m (164 ft) from the reservoir shoreline. The ring is partly covered by sediments and largely hidden from view. The ring is approximately four m (13 ft) in diameter and is made of about 55 river cobbles and boulders. Three unmodified flakes of mottled gray chert were found in a small eroded surface inside the ring indicating some manner of tool manufacture was undertaken at the site. This site lies outside the project area, and so was not evaluated as to its eligibility for inclusion in the register.

E.4.2 Measures for Locating, Identifying, and Salvaging Historical and Archaeological Resources

The State Historic Preservation Officer (SHPO) agreed with DNRC that sites 24BW180 and 24BW182 appear to meet the criteria for inclusion in the National Register of Historic Places (see Appendix E-2), SHPO also agreed that 24BW182 is valuable for the information it might yield through excavation, rather than through in-place preservation. If the Keeper of the Register, Heritage Conservation and Recreation Service, were to determine that site 24BW182 was eligible for inclusion in the register, DNRC would consult further with SHPO and the President's Advisory Council on Historic Preservation to plan for mitigation.

DNRC and SHPO would recommend a program of professionally adequate data recovery sufficient to justify a "no adverse effect determination" (36CFR800.3). A "no adverse effect" is recommended because portions of the site are actively eroding and will be destroyed whether or not the project is authorized. If the hydro-electric project were constructed, a portion of the site would be inundated.

The criteria of "no adverse effect" for archaeological resources have been applied as follows:

1. 24BW182 is not a National Landmark, a National Historic Site, nor a property of national historic significance as designated within the National Park System.

2. In-place preservation of the site is not necessary to fulfill purposes of the Montana State Historic Preservation Plan.

3. DNRC is recommending to the Montana SHPO that:

a. The archaeological site has minimal value as an exhibit or interpretive site since it has no visible structural remains and is mostly buried in a geological context. Access to the site would be difficult for the general public.

b. Scientific retrieval of the data would not affect any Native American groups or ethnic communities which might assign cultural or historical significance to the site.

c. Currently available archaeological techniques and methods would be used to retrieve data from the site.

4. DNRC funds and time would be committed to adequately retrieve the archaeological data.

Research Design

At site 24BW182, detailed study of the cultural and natural stratigraphy, recovery of diagnostics through controlled excavations, and excavation of fire hearths and other features could provide invaluable data regarding the prehistoric cultural sequence, and the environmental settings of southwestern Montana. Detailed analyses of

lithic material and faunal remains should reveal patterns of lithic technological development and the relationships among tool assemblages; information about prehistoric diets, subsistence techniques, and seasonality; and prehistoric adaptive changes through time.

DNRC archaeologists would visit the coke oven, site 24BW180, annually for five years to determine if increased visitor use of the area was contributing to increased vandalism. If vandalism occurred on the site as a result of the project, DNRC would consult with SHPO and the Advisory Council on Historic Preservation to determine what measures should be taken to protect the resource.

Site 24BW181, the tipi ring, would not be directly affected by the reservoir, but would be checked periodically to ensure it was not being vandalized, or damaged by unforeseen effects of the project.

E.4.3 Salvage Activities

(A) Schedule

1. Field Work

Archaeological investigations around Broadwater Reservoir would be conducted in late fall, when the reservoir is drawn down. It is recommended that five weeks be spent excavating from approximately October 1 through November 7, 1983. The anticipated field crew would include one principal investigator and three field researchers.

2. Laboratory Work and Site Analysis

This phase of the project would begin after the completion of the field work about November 7. Analysis would be performed by the principal investigator and one field researcher. The zoological and botanical phases of the analysis, would be contracted. Completion of the laboratory work would be approximately January 7, 1984, when a preliminary report would be completed.

3. Report Preparation

The principal investigator would complete a draft of the final report by February 7, 1984. A final site excavation report would be complete by March 7, 1984. Fifteen copies of the report would be submitted to appropriate agencies (SHPO, FERC and BLM) for review and comment. The University of Montana, Montana State University, and the Montana State Library also would receive copies.

B. Cost Estimates

The estimated cost of mitigating the archaelogical and historical effects of the project are as shown below.

Personal Services	
Salaries	$16,203
Benefits	3,078
Total	$19,281
Operating Expenses	
Supplies and Materials	$ 400
Travel	750
Contracted Services	1,800
Total	$ 2,950
Equipment	$ 350
TOTAL	$22,581

Funding would be provided through bonding, as with the rest of the proposed project. Other options for funding will be pursued during the interim, and, if money is available, the studies may be conducted sooner than anticipated.

E.5 RECREATIONAL RESOURCES

E.5.1 Existing Recreational Facilities

Recreational development at the dam is minimal, with two pit toilets, one trash can and one picnic table. All of these are available for public use, but are severely deteriorated and in need of replacement. A sloping unsurfaced area just upstream from the dam serves as a boat access, and open space downstream is used for parking. A walkway across the dam provides access to the right bank, but handrails are worn and signs weathered to illegibility. Observation areas at the abutments show much use, but steep access paths and worn vegetation lessen their attractiveness. In short, recreational management and developed recreational opportunities in the area are virtually nonexistent.

E.5.2 Existing and Potential Recreational Use of the Area

There are several estimates of recreational use at the dam and surrounding areas (Map E-2); the estimation procedures and their results differ greatly (Table E-3). The Bureau of Land Management (BLM) described use as heavy, both above and below the dam (See Appendix E-2). Fredenberg (1980) agreed, saying the high number of fish tag returns from the dam area indicated heavy fishing pressure.

Fishing pressure appears to be heaviest during the September-October trout spawning runs. Fredenberg (1980) found that 88.5% of the total use for his primary study

MAP E-2 Existing Recreation Sites in the Toston Vicinity

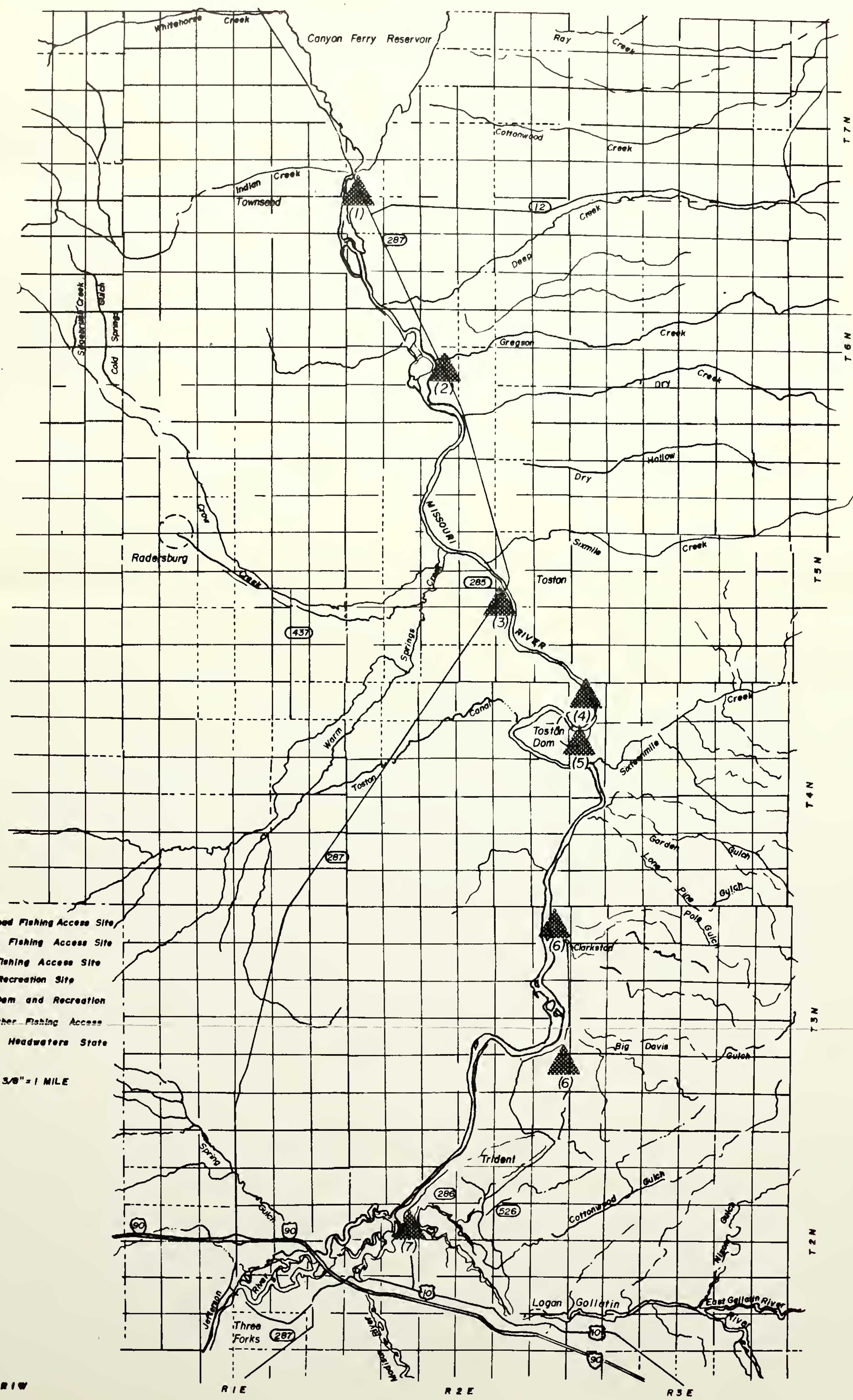


Table E-3 Recreational Use Levels at Toston Dam and Vicinity

Source	Method	Area	Use Estimate	Period
BLM[1]	Informal survey	Dam to BLM picnic site	79 individuals	Nine days in Summer, 1979
Fredenberg[2]	On-site survey	Townsend Bridge to Canyon Ferry Res.	12,000 hours	July 1-November 17, 1978
Broadwater Co. Commissioner[3]	Informal estimate	Broadwater Dam	30-25 cars/weekdays 40-50 cars/weekdays	Summer use season
DFWP[4]	Mail survey	Dam to Canyon Ferry Reservoir	4619 man-days	May-September, 1975
DFWP[5]	Traffic count	Deepdale F.A.S.	1098 vehicles	May 24-September 30, 1980
DFWP[5]	Traffic count	Fairweather F.A.S.	411 vehicles	94 days in summer, 1980
DFWP[5]	Camp permit Sales	Missouri Headwaters State Park	1050 permits	June 1-August 30, 1980

1. Appendix B.
2. See references; Fredenberg notes this figure may represent only 79% of actual total fishing use.
3. Meeting of November 7, 1980, Townsend, MT.
4. MT Bureau of Outdoor Recreation Project #30-00275, Montana Department of Fish & Game.
5. Appendix B.

area occurred between September 9 and November 17. Another important use of the area comes with the annual Toston Fish Derby, held the last weekend in August. Up to 400 anglers and spectators crowd the river from Broadwater Dam to the irrigation crossing at the BLM recreation site. Winter use of the site for recreation appears minimal.

The best use estimate for the general area (Fredenberg 1980) is shown in Table E-4. Unfortunately, these data contain little specific information about the area immediately upstream and downstream from the dam. Such information could be gathered as part of the BLM land use plan or DFWP study. This would provide the additional data from which to estimate current and potential use of the area. The Department of Highways Travel Promotion Unit termed the site a valuable recreational resource which has not yet been promoted to its full potential, (Wilson 1980), which indicates use rates could increase.

E.5.3 Recommended Recreational Facilities and Measures

The Broadwater County Commissioners, DFWP, BLM, and Heritage Conservation and Recreation Service (HCRS) supplied DNRC with recommendations for recreational development (Appendix E-2).

The Broadwater County Commissioners (1980) recommended installing new latrines, a picnic area, off-road parking, a warning system to keep boaters from going over the dam, and a camping area at the dam site. They also wanted to

TABLE E-4 Additional Recreational Use Data for Broadwater Dam Area*

Parameter	Primary Study Area (Townsend Bridge to Canyon Ferry Res.)	Secondary Study Area (Broadwater Dam to Townsend Bridge)
Sample size	1274	293
Average stay	3 hours	n.a.
Timing of use	59% weekdays	n.a.
Average group size	2.04	n.a.
Boat use	15%	100%
Harvest rate	.67 trout/hour	.23 trout/hour
Predominant fish type	Rainbow trout	Brown trout
Use estimate	12,000 hours (see Table E-3)	n.a.
User residences:		
Local	23%	20%
Helena	21%	37%
Butte	9%	11%
Bozeman	16%	5%
Other MT	11%	14%
Out of State	20%	13%

*Fredenberg 1980

improve boater access, but without adding major boat ramp facilities.

DFWP has been consultated throughout the term of the preliminary permit and they have suggested several measures and facilities to improve recreation at the dam site (See Appendix E-2). Noting the site's run-down condition, they recommended removing the two latrines and picnic table, and improving area maintenance. Suggested developments below the dam included parking lot surfacing, parallel parking designation, and latrine installation. They further recommended creating a parking, picnic, and boat launching area with new latrines, signs and appropriate barriers on BLM land above the dam, in the event existing facilities were destroyed or rendered useless by the proposed project. Their letter of February 4, 1982 is to clarify their position regarding recreational development in conjunction with the proposed hydroelectric project.

BLM has also been consulted throughout the term of the preliminary permit and has pointed out that its land just upstream from the dam on the left bank has potential for development as a picnic and boating area, and that its land downstream from the dam could be developed as a picnic area (see Appendix E-2). BLM currently is preparing a land use plan for this area, and expects to complete it in 1983. As noted in BLM's response (Appendix E-2), BLM is willing to cooperate with DNRC on development of its land for recreation. The agency also urged that fishing opportunities immediately below the dam not be displaced. BLM's letter of March 19, 1982 clarifies their position on

recreational development in conjunction with the proposed hydroelectric facility. Therein, they endorse the improvements agreed to between DFWP and DNRC.

HCRS supported the proposed recreational development, emphasizing that any recreation facilities lost because of the project should be replaced. The agency also requested an interpretive sign explaining the historic significance of the Lewis and Clark Trail.

E.5.4 Existing and Proposed Recreational Facilities and Measures

DNRC believes that any recreation plan should maintain a largely natural, primitive setting while protecting the resource and permitting safe recreational use. The plan should heed the advice of the Missouri River Basin Commission (1979a), which said the scale and type of recreational facilities should match the demands. DNRC will continue to provide access to the project area and will replace, improve, and maintain the existing recreational facilities.

Measures and facilities to be continued or maintained are as follows:

(1) An observation area at the left abutment of the dam will be eliminated by construction of the substation, however, similar opportunities will be maintained from the walkway over the dam and the right abutment.

(2) Access to the boat landing area above the dam would be maintained both during and following construction.

(3) Attempts would be made to minimize construction-recreation conflicts during periods of heavy use, such as the fall fishing season, Toston Fish Derby, and other critical periods.

(4) Access across the dam to the east bank would remain, with improved signing and guard rails. Fishing opportunities immediately downstream from the dam would remain as they are.

DNRC proposes the following new measures and facilities for the purpose of creating, preserving, and enhancing the recreational opportunities and ensuring the safety of the public in its use of project lands and waters.

(1) As recommended by DFWP, the site's run-down condition would be improved by removing the two latrines, picnic table, and litter.

(2) As recommended by DFWP, the parking areas, boat access and road will be graveled, a latrine will be provided, and picnic tables, trash cans, and signs installed.

(3) Upon completion of the BLM land use plan, DNRC would cooperate with BLM and DFWP on the design

and management of future recreation facilities at the site.

(4) DNRC would replace or improve the signing and guard rails across the dam to the east bank to ensure public safety.

(5) If the increased pool level results in damage to the boat landing area, improvements will be made to maintain service at least equal to that which currently exists.

(6) As requested by the Broadwater County Commissioners, there would be no development of piers, boat docks, or other major shoreline facilities.

E.5.5 Specifications on Measures and Facilities

(A) Responsibile Entities

DNRC will be ~~be~~ responsible for the cost, construction, and maintenance of the measures and facilities listed in Section E.5.4 for current development. DNRC would cooperate with the responsible agencies for the development of future recreation facilities.

(B) Schedule

DNRC would implement the measures and facilities discussed as an integral part of construction of the

proposed project. Negotiation and cooperation with responsible agencies will begin upon receipt by DNRC of a request for such cooperation and negotiation.

(C) Costs

The estimated costs of the proposed measures and facilities outlined above are as follows:

	Price	Quantity	TOTAL COST
Double seal vault latrine	$8,000.00	1	$8,000.00
Gravel surfacing/ road improvement	.40 sq ft	20,000 sq ft	8,000.00
Picnic tables	250.00/each	3	750.00
Trash cans	50.00	6	300.00
Signs	750.00	misc.	750.00
Initial area cleanup	300.00	1	300.00
TOTAL			$18,100.00

Recreation financing would be part of total construction costs financed through the bonding process.

(D) Map

SEE MAP E-1 AND E-2 (ALREADY REFERENCED).

E.5.6 Special Land Designations

Much of the river is natural in character with minimal development, but no areas within or near the project boundary are included or recommended for study in the National Wild and Scenic River or National Wilderness Preservation Systems. The Montana Statewide Comprehensive Outdoor Recreation Plan (Montana Department of Fish & Game 1978), however, identified the Missouri from Broadwater Dam to its confluence with the Smith River as having free-flowing values. Nearly half of this 138 km (86 mi) stretch already is impounded, which increases the value of the remaining sections.

Similarly, a Missouri River Basin Commission report (1979b) suggested that the State of Montana study the Gallatin, Jefferson and Madison Rivers for possible protection. These three rivers converge to form the Missouri about 34 km (21 mi) upstream from Broadwater Dam, which is the farthest upstream impoundment on the Missouri mainstem. The Missouri also is associated with the Lewis and Clark National Historic Trail, adding historical significance but no management obligations to the project area.

E.6 LAND MANAGEMENT AND AESTHETICS

E.6.1 Development and Use of Project Land

The project would be on land classified as Agricultural/Suburban in the Broadwater County Comprehensive Plan. Land with that designation may be used for agricultural purposes, residential subdivision or other

compatible purposes. Land that would be affected by the project currently is used for recreation, wildlife habitat, grazing and mining, and as railroad bed by the Burlington Northern. Land immediately outside the project area is used for grazing.

A. Mining

There is a one-man gold mining operation approximately 1.6 km (one mi) above the dam on land owned by BLM, a private landowner, and DNRC (see map E-1). This is a small placer operation with settling ponds seeping water back into the Missouri River. The settling ponds and excavation areas would be subject to increased groundwater levels.

B. Railroad

A Burlington Northern Railroad mainline enters the northwest corner of Broadwater County and follows the east bank of the Missouri River past Broadwater Dam and reservoir and along the river until it leaves the county.

The abandoned Milwaukee Road tracks cross the Missouri River eight km (five mi) upstream at Lombard.

C. Land Ownership

Owners of land abutting the project include DNRC, BLM, the Burlington Northern Railroad, the Milwaukee Road, and several private citizens (see Exhibit G-1).

E.6.2 Visual Impacts

If the water level were raised to 1204.7 m (3952.6 ft), as proposed, visual impacts along the reservoir would be more evident than at present. Visual diversity would decrease as vegetation and landforms became submerged.

Fill from excavation would be used in berms to soften the hard visual impact of the proposed structure. The power lines would be routed through a small drainage to the south of the dam to minimize their visual impact.

The higher pool level would affect the present boat access and reduce the adjacent vehicle turn-around area, requiring improvement and possible relocation of these facilities. Careful design and construction procedures would leave intact much of the juniper, yucca, prickly pear, and sagebrush, while improving public access.

E.6.3 Wetlands and Floodplains

There are relatively small areas of wetland and floodplain on islands and around the perimeter of the existing reservoir. Botanical and wildlife aspects of these areas are detailed in Section E.3 of this exhibit. The increased pool level that would result from the proposed project would obliterate some of these areas and create new ones. Some of the new areas would be adjacent to the existing ones, but higher on the shore to match the increased pool level. Other new wetlands would be created where currently there are none. Such areas could include

the waterline at Devil's Bottom, the bench at the river bend just above Island Group B, the railroad borrow pits, and the floodplains on the west bank just below the Lombard Bridge (see Map E-1).

Existing wetlands that would be inundated include the cattail marshes located at the head of the dam and near Island Group B.

The existence of only small areas of floodplain along the reservoir minimize the opportunity for the development of new marsh habitats similar to those now found near Island Group B. Such habitats require relatively flat river bottom approximately .3 to .6 m (one to two ft) under the water surface. The study by DFWP will determine whether the new water level resulting from the project would create new marsh habitat. It appears likely that a net loss of such habitat would result from the project.

E.6.4 Provisions for Continued Public Access

Any increased demand for public access to the impoundment would have to be met by the existing boat ramp.

Signs warning boaters of the dam and indicating the boat access point would be placed on the banks at a safe distance upstream from the dam.

E.6.5 DNRC Policy on Shoreline Facilities

DNRC proposes to cooperate with BLM and DFWP to implement the results of their investigations. Efforts will be made to maintain a largely natural, primitive setting while protecting the resource and providing safe recreational use.

As requested by the Broadwater County Commissioners, there would be no development of piers, boat docks or other major shoreline facilities other than the slight upgrading of the existing boat ramp as required by the raised water level.

E.6.6 Map

The two maps accompanying Exhibit E are referenced and included earlier in this report.

E.7 REFERENCES CITED

Ballou, Robert M. 1979.
For Wally Steucke, area manager, Fish and Wildlife Service, Letter to Kenneth F. Plumb, Secretary, U.S. Federal Energy Regulatory Commission, July 19. Billings.

Broadwater County Commissioner. 1980.
Meeting (November 7) with Edrie Vinson, Project Manager for environmental review, and David Ford, Assitant, Broadwater Hydroelectric Project. Townsend.

Craighead, J. J., and Craighead L. 1979.
An Assessment of the ecological impacts of the Libby additional units and reregulating dam (LAVRD) project and Libby dam on the American bald eagle. Final report, U.S.Army Corps of Engineers. Contract DACW67-78-C-0109.

Elliot, W. 1980.
Biologist,Bureau of Land Management, District Office, Butte, Montana. Conversation (October 27) with Larry Thompson, Biological Sciences Coordinator, Montana Department of Natural Resources and Conversation. Helena.

Fredenberg, W. A. 1980.
The Fishery for fall-running Brown and Rainbow Trout in the Missouri River near Townsend, Montana. M.S. thesis, Montana State University. Bozeman.

Herbert, J. 1980.
Biologist, Montana Department of Fish, Wildlife and Parks, Townsend, Montana. Conversation (November 20) with Larry Thompson, Biological Sciences Coordinator, Montana Department of Natural Resources and Conservation. Townsend.

Meyer, S. R. 1979.
Northwest Montana/North Idaho Transmission Corridor Bald Eagle Study. Bonneville Power Administration, Portland, Or.

Missouri River Basin Commission. 1979a.
Upper Missouri River Basin Level B Study including draft EIS, Main report. Missouri River Basin Commission.

Missouri River Basin Commission. 1979b.
Outdoor Recreation Technical Paper. Upper Missouri River Level B Study. Helena.

Montana Department of Fish and Game. 1978.
Montana Statewide Comprehensive Outdoor Recreation Plan (SCORP). Helena.

Montana Department of Fish, Wildlife and Parks. 1980.
Montana Interagency Stream data base. Helena.

Montana Department of Health and Environmental Sciences. 1980.
Water Quality in Montana. Water Quality Bureau. Helena.

Tudor Engineering. 1979.
Vertical Turbine-Spillway Combine Broadwater Dam. Final Report. Cooperative Agreement no. EW-78-F-07-1822 TudorEngineering Company. San Francisco, CA.

Wilson, J. 1980.
Travel Promotion Unit, Montana Department of Highways. Conversation (November 5) with Stewart Allen,

Environmental Specialist, Montana Department of Natural Resources and Conservation. Helena.

Yannone, V. 1980.
Biologist, Montana Department of Fish Wildlife and Parks, Helena, Montana. Conversation with Larry Thompson, Biological Services Coordinator, Montana Department of Natural Resources and Conservation. Helena.

APPENDIX E-1

FISH AND WILDLIFE PROPOSAL

A Study Proposal to Determine the Need for a Fishway at Toston Dam on the Missouri River

By

Montana Department of Fish, Wildlife and Parks
1420 East 6th Avenue
Helena, Montana 59620

December 10, 1980

BACKGROUND

The Montana Department of Fish, Wildlife and Parks (MDFWP) began in 1978 to evaluate the fishery and recreational resources of the free-flowing section of the Missouri River between Toston Dam and Canyon Ferry Reservoir. Prior to 1978, little quantitative information had been gathered for this 21-mile section of river even though it had been designated by the Montana Fish and Game Commission as one of Montana's "Blue Ribbon" waterways in recognition of its high fishery, recreational and aesthetic values.

During this on-going investigation, river fish populations are being censused with a boat-mounted electrofishing unit to determine species composition, distribution, relative abundance and size composition. Numbers and biomass of the resident trout population are also being estimated in selected study sections using a mark-recapture method. Some trout are tagged to determine movement patterns of individual fish, particularly spawners. Tag return data also provide an index of the utilization of the fishery by anglers. In conjunction with this investigation, a partial creel census to determine fishing pressure, catch rates and harvest was conducted by a graduate student at Montana State University as a M.S. thesis project.

Preliminary study results show that this "Blue Ribbon" section of river supports a resident trout population that is characterized by the presence of substantial numbers of larger-size brown trout. A brown trout population estimate was made for the river in spring, 1980. The preliminary estimate of numbers is as follows:

Size Interval (Inches)	Estimated Number of Brown Trout per Mile of River
7.0 - 10.4	29
10.5 - 11.9	76
12.0 - 15.9	119
16.0 and longer	58
	282

Rainbow trout are also present, comprising about 32 percent of the resident trout population by numbers. Other resident fish and their relative abundance are:

Mountain Whitefish	abundant
Cutthroat Trout	rare
Brook Trout	rare
Yellow Perch	rare
Flathead Chub	rare
Longnose Dace	rare
Carp	abundant
White Sucker	abundant
Longnose Sucker	abundant
Stonecat	common

This 21-mile section of river is particularly noted for providing an outstanding recreational fishery during the fall when brown trout residing in Canyon Ferry Reservoir enter the river on their annual spawning migration. An exceptional fall run of rainbow trout also occurs during this period. Unlike the brown trout, the fall running rainbow trout primarily congregate in the lower 2.2 miles of river between Townsend and the reservoir. This fall run of rainbow trout is believed to be comprised primarily of fish of hatchery origin. Canyon Ferry Reservoir is annually planted with about 650,000 juvenile, hatchery rainbow trout of a domestic stock. Due to their genetic make-up, these planted fish become sexually mature during the fall while wild rainbow trout become sexually mature in the spring when rainbow spawning normally occurs. It is doubtful the fall maturing rainbow trout successfully reproduce in the river system and contribute recruits to the reservoir fishery. In the future, the department may choose to establish a reproducing, self-sustaining population by switching to plants of a wild strain of spring spawning rainbow trout. In the two reservoir systems in southwest Montana (Hyalite and Harrison) where experimental plants of wild trout stocks have occurred, the recreational fishery exhibited a dramatic improvement. This switch to wild stocks may become a preferred management option if and when an adequate source of these stocks becomes available. This change in management policy could lead to a significant movement of rainbow trout into the river during the spring spawning period and possibly require the passage of these fish over Toston Dam if existing spawning areas below the dam are inadequate. The overwhelming success of these experimental plants in the other reservoir systems suggests that the establishment of a spring spawning run of wild rainbow trout is a realistic management option. Management options involving the establishment of other salmonid species are also possible.

The fall rainbow trout fishery of the lower river is likely a result of the Montana Department of Fish, Wildlife and Parks' present policy of planting fish of domestic, hatchery stocks although fall runs into river systems also characterize some lake inhabiting populations of wild, spring spawning rainbow trout. Wild stocks of rainbow trout, if present, may also comprise a portion of the fall run.

The existence of a spring spawning run of wild rainbow trout from Canyon Ferry Reservoir is undocumented at present, although anglers report catching larger-size rainbow trout in the river during this period.

Migratory, adult rainbow and brown trout residing in Canyon Ferry Reservoir are primarily responsible for the exceptional recreational fishery that exists in the Missouri River between Toston Dam and Canyon Ferry Reservoir during the fall period. At present, limited information is available concerning the magnitude of these fall runs and the distribution of these migrants within the river system. The importance of the river system in providing recruits for the reservoir trout fishery is also unquantified at present. The presence of migrant brown trout within the river during

the annual spawning period suggests that the river does provide some spawning habitat and, consequently, is contributing to reservoir recruitment.

The existing dam at Toston blocks the upper river system to migrant trout, preventing access to the uppermost 21 miles of the Missouri River and the Madison, Gallatin and Jefferson River systems. Access to these river systems could enhance the existing recreational fishery by providing additional spawning and nursery areas for the migratory trout population of Canyon Ferry Reservoir and, thereby, increase the level of recruitment into the reservoir population. A greater reservoir population could conceivably provide more migrants for the river sport fishery. Access to the upper river systems could also increase recreational opportunities by allowing anglers to catch these larger-size migrants in the lower reaches of the Jefferson, Madison and Gallatin Rivers and innumerable smaller tributaries. Whether or not access to these river systems would in fact enhance the existing recreational fishery is unknown.

PROJECT PROPOSAL

This proposal is primarily intended to answer the question of whether or not a fishway and associated turbine bypass system be included, or provisions made for future adaptation of such, in the plan to convert the existing Toston Dam to hydro-electric generation. The proposal is designed to meet anticipated funding limitations, yet provide sound biological information based on a comprehensive literature search and a field investigation to decide the need for a fishery.

Phase I

The literature review phase of the proposal is intended to provide insight into many questions related to fishways and their anticipated impacts on a recreational fishery. The opinions of outside experts will also be incorporated into this phase. Questions to be researched include the following:

1. Does the literature contain evaluations of comparable reservoir-river systems having fishways and, if so, what were the impacts on the recreational fishery?

2. If the MDFWP chooses to modify its fishery management program for the Canyon Ferry Reservoir - Missouri River complex in the future, what are the viable options given the physical, chemical and other constraints of the system? Will a fishway hinder or facilitate the implementation of these options?

3. Considering the environmental problems currently affecting the upper Missouri River and its major tributaries, is it realistic to expect that passage into these presently inaccessible waterways will ultimately increase the recruitment rates into the Canyon Ferry trout fishery and, consequently, provide more migrants for the river sport fishery?

4. Are there behavioral characteristics of salmonids that

should be considered when formulating a decision to include or exclude a fishway? For example, enhancing the brown trout fishery of Canyon Ferry Reservoir may not be desirable when considering their low catch-ability relative to that of other salmonid species in a reservoir environment.

5. What operational and design criteria must be implemented to facilitate the successful upstream passage of spawners and the downstream passage of spent spawners and smolts? During what periods will upstream and downstream passage be required and what are the success rates that can be anticipated given the design of the dam and turbines? What quantity of water must be passed through the fishway to provide acceptable passage rates?

6. Is it possible to predict what the impacts of a migrant fishery will be on the existing resident populations in the river systems that are presently inaccessible to these migrants?

Phase II

The field investigation phase of the study will determine whether or not the existing migrant trout fishery warrants a fishway. The following field study is proposed to provide this information:

1. During the fall brown trout and spring rainbow trout spawning periods, equal electrofishing effort will be expended on a series of river study sections between Toston Dam and Canyon Ferry Reservoir to determine the relative abundance of the migrant trout within the river system. These electrofishing surveys will occur at least four times during the fall and spring spawning periods. If high concentrations of migrants are found immediately below Toston Dam, it may be assumed that the dam is blocking a significant portion of the spawning run and, consequently, would lend support to the need for a fishway.

2. During the electrofishing surveys, captured migrants will be marked with numbered Floy T-tags. The recapture of tagged trout during subsequent electrofishing surveys will provide an index of the rate of spawning movement within the 21 miles of river below Toston Dam. Rapid, upstream movement of tagged trout would imply that spawning conditions are unsuitable and passage over the dam to more suitable areas may be desirable.

3. An attempt will be made to locate existing migrant spawning areas in the river below Toston Dam. Side channels, which are typically chosen as spawning sites by river trout populations, will be electrofished. High concentrations of gravid females remaining within these areas will be indicative of spawning usage if actual redds cannot be found.

4. Migrant trout captured by electrofishing immediately downstream of Toston Dam will be tagged and released upstream of the dam. Tag returns will provide information on spawning movement within the river systems previously inaccessible to the migrants. The success of this phase of the proposed study

will depend on the ability to capture substantial numbers of migrants below the dam. If this is not possible, this phase of the study will be abandoned.

Phase III

The impact of the Toston Dam Hydroelectric Project on island habitat and, consequently, wildlife populations will also be addressed in this study proposal. The project may permanently raise the water levels of Toston Reservoir above existing levels and, thereby, partially or totally inundate islands located at the head of the reservoir. Islands are important to many wildlife species, particularly to the Canada goose which uses them for nesting and brooding areas. The permanent flooding of islands or flooding during the critical nesting period could impact Canada goose production. Other game species such as white-tailed deer and ring-necked pheasant and furbearers such as river otter and beaver also utilize island habitats. This phase of the study will determine the present usage of these islands by wildlife species and the probable impacts of flooding on these populations.

Other Considerations

During the literature review phase of the proposed study, it may be determined that insufficient water is available to successfully operate the fishway during the required passage periods. Economic considerations may also exclude the possibility of incorporating a fishway into the project. If this should occur, the flexibility to redirect the efforts of Phase II of the study should be available.

PROPOSED BUDGET

This proposed project will begin on April 1, 1981. The first year's (1981) budget is as follows:

Salaries and Benefits	
Project Leader (Grade 13/1 for 9 months)	$11,515
Fishery Assitant (Grade 7/1 for 4 months)	3,090
Benefits at 20%	2,921
	$17,526
Travel and Per Diem	
7,500 miles at $0.25/mile	$ 1,875
Per Diem	1,500
	$ 3,375
Supplies	$ 1,500
Equipment	$ 1,000
Administrative Overhead at 7.7%	1,802
TOTAL	$25,203

It is recommended that this project be continued for an additional field season. The second year's (1982) budget is as follows:

Salaries and Benefits	
Project Leader (Grade 13/1 for 9 months)	$12,206
Fishery Assistant (Grade 7/1 for 4 months)	3,275
Benefits at 20%	3,096
	$18,577
Travel and Per Diem	
7500 miles at $0.25/mile	$ 1,875
Per Diem	1,500
	$ 3,375
Supplies	$ 1,000
Equipment	$ 750
Administrative Overhead at 7.7%	1,825
TOTAL	$25,527

LITERATURE CITED

Fredenberg, W. A. 1980. The fishery for fall-running rainbow trout in the Missouri River near Townsend, Montana. M.S. thesis, Montana State Univ., Bozeman. 62 pp.

APPENDIX E-2

AGENCY CORRESPONDENCE

APPENDIX B

AGENCY-APPLICANT COMMUNICATION

This appendix contains correspondence between the Applicant and various agencies. The items contained in this appendix are:

Item I - Correspondence regarding information on the project.

(a) DNRC request to federal, state, and local agencies requesting comments, recommendations, and information on the proposed project.

(b) Comments, recommendations, and information received from federal agencies.

- (1) Bureau of Land Management
- (2) Heritage Conservation and Recreation Service
- (3) Fish and Wildlife Service
- (4) Geological Survey
- (5) Federal Energy Regulatory Commission

(c) Comments, recommendations, and information received from state agencies.

- (1) Department of Fish, Wildlife and Parks
- (2) Montana Historic Preservation Office
- (3) Department of Health and Environmental Science

(d) Comments, recommendations. and information received from local agencies.

- (1) Notes from meeting with Broadwater County Commissioners

DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION
FACILITY SITING DIVISION

THOMAS L. JUDGE, GOVERNOR — 32 SOUTH EWING

STATE OF MONTANA

(406) 449-4600 — HELENA, MONTANA 59601

MEMORANDUM

TO: Interested Parties

FROM: Edrie Vinson, Project Manager
Broadwater Hydroelectric Project No. 2853
Projects Bureau (PB)
Facility Siting Division (FSD)
Department of Natural Resources & Conservation

DATE: October 31, 1980

RE: Environmental Review - Broadwater Hydroelectric Project No. 2853

The Facility Siting Division of the, Montana Department of Natural Resources & Conservation is preparing an environmental report, which will meet the requirements of (a) a Preliminary Environmental Review under the Environmental Protection Agency and (b) Federal Energy Regulation Commission application requirements. DNRC's proposal to install four (4) hydroelectirc generating units at the DNRC's existing Broadwater (Toston) Dam. As specified by Federal Energy Regulatory Commission (FERC) requirements for hydropower license applications, the DNRC must prepare this report in consultation with local, state, and federal agencies having environmental expertise.

Please let us know if you have information, comments or advice bearing on the proposed project.

Located on the Missouri River in Broadwater County, Montana, the dam presently backs up water for four and one-half ($4\frac{1}{2}$) miles. Construction would take place over a one and one-half ($1\frac{1}{2}$) year period, utilizing a peak work force of thirty (30). Existing roads would be used, with upgrading and maintanance as needed. Following construction, raods would be left in their existing condition.

Your assistance in preparing the environmental report would be appreciated. A list of all agencies contacted is attached; if you note any omissions, please inform us.

Thank you.

Sincerely,

Edrie Vinson

Edrie Vinson
Project Manager
Broadwater Hydroelectric Project
Projects Bureau

Dr. Robert Archibald, Director
Montana Historical Society
225 N. Roberts
Helena, MT 59601

Gordon E. Bollinger, Chairman
Montana Public Service Commission
1227 11th Ave.
Helena, MT 59601

Robert L. Davis, Chairman
Broadwater - Missouri Water
Route 1 Box 23
Townsend, MT 59644

Chris Deleporte
Hereitage Conservation & Recreation Service
440 G. Street N.W.
Washington, D.C. 20243

Ralph Driear, Environmental Coordinator
Commissioner's Office
Department of State Lands
1625 11th Ave.
Helena, MT 59601

William E. Duede
Broadwater County Commissioner
Townsend, MT 59644

William V. Erbe
Land Administration Division
Department of State Lands
1625 11th Ave.
Helena, MT 59601

Ted Flynn
Broadwater County Planning Board
Townsend, MT 59644

Dr. Millard W. Hall, Chairman
Missouri River Basin Commission
Suite 403
11050 Regency Circle
Omaha, Nebraska 68114

Tomas H. Hensley
Broadwater County Commissioner
Toston, MT 59643

Don Minnich
Regional Director, Region 6
U.S. Fish - Wildlife Service
Denver Federal Center
P.O. Box 25486
Denver, Colorado 80225

Mr. Alan Merson
Regional Administrator, Region VIII
Environmental Protection Agency
301 S. Park
Federal Building, Drawer 10096
Helena, MT 59601

Herman L. Moudree
Broadwater County Planning Board
Box 489
Townsend, MT 59644

Mike Penfold, State Director
Bureau of Land Management
U.S. Department of Interior
P.O. Box 30157
Billings, MT 59107

Larry Peterman
State of Montana
Department of FIsh, Wildlife, and Parks
1420 East Sixth
Helena, MT 59601

Steven Pilcher
Water Quality Bureau
Department of Health & Environmental Sciences
Cogswell Building, Room A 206
Helena, MT 59601

Harold M. Price, Administrator
Community Development Division
Department of Community Affairs
1424 9th Ave.
Helena, MT 59601

Ronald P. Richards, Director
Department of Highways
Room A 261, Highway Building
2701 Prospect Ave.
Helena, MT 59601

Lawerence Siroky
Water Rights Bureau
Water Resources Division
Department of Natural Resources and Conservation
32 S. Ewing Helena, MT 59601

Wally Steucke, Area Manager
U.S. Fish & Wildlife Service
Federal Building, Room 3035
Billings, MT 59101

Col. B.D. Stipo, District Engineer
U.S. Army Corps of Engineers
6014 U.S. Post office & Courthouse
215 N. 17 Street
Omaha, Nebraska 68102

United States Department of the Interior

IN REPLY REFER TO
2300

BUREAU OF LAND MANAGEMENT
District Office
Box 3388
Butte, Montana 59702

MAR 19 1982

RECEIVED
MAR 24 1982
MONT. DEPT. of NATURAL RESOURCES & CONSERVATION

Norman W. Barnard
Hydropower Engineer
Engineering Bureau
Dept. Natural Resources & Conservation
32 South Ewing
Helena, Montana 59601

Dear Mr. Barnard:

In response to your recent letter and telephone conversation with MaryAlice Stoner of this office, we feel that the suggested low level of development of the recreational facilities around Toston Dam is logical, especially considering the cuts in funding most agencies are experiencing. It is our understanding that your department and the Department of Fish, Wildlife and Parks have reached an understanding that two toilet facilities will be placed in the general vicinity of the existing facilities. These new facilities will replace the existing ones which are beyond the limits of safety and sanitation. In addition, two picnic tables will be placed in the same general vicinity in order to enhance the recreational opportunity below the Toston Dam.

In addition to the above facilities planned by DNRC and MDFW&P, this past year we placed two picnic tables and two fire rings on BLM land about ½ mile below the dam. Paths through the brush allow angler access to the river from these sites. Hopefully, these sites will help draw some of the heavy overnight use from near the dam, but it is doubtful that they will reduce the fishing pressure in the immediate vicinity of the dam.

We support the continuation of use of the rough boat launching facility above the dam on DNRC lands. Gravelling the road and improving the bridge across the Toston Canal definitely are a positive step.

If additional facilities are justified in the future by an increased demand, the Bureau would consider additional facilities on the BLM land located adjacent and upstream to the DNRC lands. However, such development would have to be consistent with our land use planning and budgetary constraints.

For your information, we have enclosed some information on toilet facilities which are reputed to be nearly indestructable. They have been used nn several Forest Service sites, including ones administered by the White Sulphur Springs Ranger District. We have not installed this style of toilet as yet, but will consider it strongly in the future based on the positive feedback we have received from others who have used them.

Please keep us informed on the progress of this project as it relates to BLM and let us know when it becomes apparent when construction will begin.

Sincerely yours,

Jack A. McIntosh

Jack A. McIntosh
District Manager

Enclosure

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
Headwaters Resource Area
Box 3388
Butte, Montana 59701

IN REPLY REFER TO
2300

NOV 17 1980

Edrie Vinson, Project Manager
Broadwater Hydroelectric Project
Facility Siting Division
Dept. of Natural Resources & Conservation
32 South Ewing
Helena, Montana 59601

Dear Ms. Vinson:

Thank you for advising us of the investigation into the feasibility of a generating facility on the Broadwater (Toston) Dam.

Although the Headwaters Resource Area planning documents are not up to date, I have circulated this information among my staff and can offer some resource data which may be useful to you.

1. Recreation Management

The Toston Dam area is heavily used by recreationists, both above and below the dam. The BLM land above the dam primarily is used for fishing and for a take-out point by float boaters and some motorized boaters. The site has potential for development as a boat ramp and picnic facility. The BLM lands below the dam are heavily fished and also used for camping and picnicking. It is very rare during the use season not to find someone fishing in this area. The BLM land about ¼ mile below the dam has a very high potential for campground and picnic area development.

As per Stuart Allen's request, visitor use data is attached for the Toston Dam area.

2. Livestock Management

Three livestock grazing permittees utilize public lands above the existing dam. Very little to no impact on livestock grazing on public lands will result from the proposal due to steep slopes adjacent to the river.

3. Wildlife Habitat Management

Area is totally within Bald Eagle winter habitat. Area of the Missouri River for 1 to 1.5 miles below the existing dam is considered "crucial" habitat. During severe winter conditions, usually January-February, the Missouri from Three Forks to Canyon Ferry has very little open water. The current from the existing dam keeps the river relatively ice free during this crucial period. Eagles concentrate here and feed primarily on waterfowl and fish.

Our concern is that the new facility not reduce this current flow and that "open" water conditions be maintained. Initial feelings on this are that the new facility will not change flow patterns (pers. comm. w/ Larry Thompson, DNR, 10/27/80).

The mile of public land river frontage below the dam is being considered for recommendation to the Fiah and Wildlife Service as "essential habitat" for the Bald Eagle.

The cottonwood trees in the area are important winter roosting and perching sites for bald eaglea. We would request that none of these be removed.

The noise level of the generator is also a concern. Since a lot of roosting and perching of eagles takes place on the west bank we are concerned what, if any, the behavioral effect on eagles will be?

We are also wondering if additional powerlines will be required or will existing lines be used?

As you are aware the river from Toaton to Canyon Ferry is a Class I (highest value) fishery. Upstream movement of spawning brown and rainbow trout produce excellent fishing opportunities at the existing facility because it representa a barrier to further upstream movement. We would be concerned that the gravel below the facility be maintained and that the filling of the interstices of the gravel and "cementation" not occur as sometimes results with constant discharge from generating facilities.

This may be a prudent time to consider the feasibility and necessity of a fish passage structure (fish ladder) around the existing facility. Although more consultation with the MDFW&P would be needed, this idea of providing access to more upstream spawning gravels has been viewed favorably by personnel of different resource agencies.

Again, thank you for the opportunity to comment.

Sincerely yours,

Lyle G. Fox
Lyle G. Fox
Area Manager

Encloaurea

TABLE 1
Number in Party

Party Size	Parties #	Parties %	People #	People %
1	5	17	5	6
2	11	38	22	28
3	4	14	12	15
4	7	25	28	36
5	1	3	5	6
6				
7	1	3	7	9
Total	29	100	79	100

TABLE 2
Type of Party

Type	Parties #	Parties %
Family	16	56
Family & Friends	5	17
Friends & Acquaintances	3	10
Individuals	5	17
Total	29	100

TABLE 3
Number by Age and Sex

Age	Male #	Male %	Female #	Female %	Total #	Total %
1-19	11	23	3	11	14	18
20-29	4	8	5	19	9	11
30-39	14	29	6	22	20	25
40-49	10	20	4	15	14	18
50-59	7	14	7	26	14	18
60 +	3	6	2	7	5	6
Unknown					3	4
Total	49	100	27	100	70	100

TABLE 4
Origin of User

County	Vehicle #	Vehicle %
Silver Bow	3	10
Cascade	1	4
Yellowstone	4	14
Missoula	1	4
Lewis & Clark	8	29
Gallatin	5	18
Beaverhead	1	4
Broadwater	3	10
Unknown	2	7
Total	28	100

TABLE 5
Type of Use

Type	Parties #	Parties %
Day Use	19	59
Overnight	9	28
Unknown	4	13
Total	32	100

VISITOR USE- TOSTON DAM AREA
(Above Toston Dam to Toston Picnic Site)

An observer was in the area at least part of nine days in 1979. During two of these days, no visitors were seen. The observer averaged 5 hours per day on site plus he was there overnight on three occasions. Observation days were 6/17, 6/18, 7/28, 7/29, 8/3, 8/19, 8/20, 8/25 and 9/3.

Thirty-two parties were observed. Three of these 32 were evidenced by vehicles on-site, but the number of individuals in these parties is unknown. Seventy-nine individuals were observed in the remaining 29 parties for an average party size of 2.7. 94% of the parties had 4 or less members. (See table 1)

Over half of the parties were family groups (56%), while families with friends, friends and acquaintances, and individuals were distributed across the remainder (See table 2)

Nearly two-thirds of the visitors were male. Most of these were between 30 and 49 years old (49%) while 23% were less than 20 years old. The females observed were distributed evenly through the age groups. Very few senior citizens were observed. (See table 3)

Most users were from Montana, with the local counties of Lewis & Clark, Broadwater and Gallatin accounting for 57% of the instate users. (See table 4) Only six out-of-state vehicles were observed. States represented were Oregon, Colorado, California and Nevada.

Most of the parties were day users while about a third camped overnight. (See table 5)

Fishing was by far, the predominant activity with 56% of the users participating. Boating, both float and motorized, accounted for 22% of the total users, shooting guns was done by 9% and archery by 4%. Other activities were not specifically identified.

TOSTON FISH DERBY

The Toston Fish Derby has been held annually in August for at least 33 consecutive years. It attracts about 200 competitors and 200 spectators each year. Competitors spread out along the Missouri River from the Toston Dam to the irrigation crossing. Fun activities and a picnic are held on BLM's Toston Picnic Site. Originally this event was held by the Toston Rod & Gun Club. For the past few years the Broadwater Jaycees have taken that responsibility.

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
District Office
Box 3388
Butte, Montana 59702

RECEIVED
DEC 15 1980
MONT. DEPT. of NATURAL RESOURCES & CONSERVATION

IN REPLY REFER TO
2300

DEC 12 1980

Edrie Vinson, Project Manager
Broadwater Hydroelectric Project
Facility Siting Division
Dept. of Natural Resources & Conservation
32 South Ewing
Helena, Montana 59601

Dear Ms. Vinson:

We have had a number of conversations and an on-site meeting with Stuart Allen recently regarding the recreation opportunities in the vicinity of Toston Dam and particularly in relation to the nearby BLM parcels.

We are interested in developing the BLM sites along the Missouri River in Section 6 for public enjoyment. Our planning documents in the past have identified the land above the dam as suitable for a boat ramp. At that time, boating above the dam was restricted to 10 HP or less, so a ramp suitable for float boats and small motor boats was envisioned. We do not feel at this time that it is suitable to provide a ramp to accommodate larger motorboats such as are used on Canyon Ferry or the Holter-Hauser Lakes Complex. Accompanying a ramp, we would envision some sort of parking facilities and perhaps picnic facilities. A low grade road would be adequate for this type of development.

The public land below the dam has an extensive shoreline suitable for dispersed recreation such as fishing. With YACC assistance we anticipate placing some picnic tables on-site this summer, but no site development will take place. More development, such as camping or picnicing facilities are possibilities for the future. However at the present time the existence of an active mining claim affects the timing and type of development.

Basically, we are in favor of development on both of these sites, but it must be emphasized that we cannot agree to any activity plan without knowing the actual consequences of the Hydroelectric Project. There is not enough specific information available on the project at this time. In addition, we presently are in the proccess of upgrading our planning system which should be completed by October 1983. Any development will have to be coordinated with this planning effort.

As was discussed with Stuart Allen, we are interested in developing some sort of cooperative effort with the State regarding these sites. The State's responsibilty would be to accelerate development of the site through the provision of funding for facilities. BLM's responsibilty would be to manage the facilities and, depending on what is worked out, may reimburse the State for part or all of the money spent on BLM lands. BLM would be involved in the design stage and would have to prepare an EAR on the action. The possibility of utilizing YACC labor also would be explored if and when an actual activity plan is prepared.

In general, we would view the boat ramp and any accompanying facilites as a substitute for the boat access above the dam. The site below the dam eventually could add to the shore fishing, picnicing and/or camping opportunities downstream. However, neither of these sites would mitigate damages to the fishing resource and accompanying camping immediately below the dam. The lower BLM site is nearly ½ mile below the dam, and thus is not readily available for people wishing to fish at the dam. In addition, the type of fishing immediately below the dam is unique in the area and is not readily substitutable. Greater opportunities to fish along the shore further downstream or in the backwater above the dam would not replace a loss of the quantity or quality of fishing at the dam.

The chance to review the Draft Report on Recreational Resources for the project is appreciated. Some of the data presented will be helpful in our planning effort. However, under the "Recreation Plan" heading, some information needs to be corrected. There is presently no guarantee that #4 or #7 will occur. As was stated above, we are interested in developing the area, but there are many factors to be dealt with before that will happen. Also, the new boat ramp site, if developed, would mitigate the loss of the old boat ramp site. However, the present place that recreationists park and picnic is tied to the fishing opportunities immediately below the dam. The new ramp and accompanying facilities will be approximately ¼ mile above the dam. It is doubtful that people will choose to use the new site when the activity in which they wish to participate occurs at the dam.

The sentence above the list of costs indicates that BLM may reimburse the State for all those costs. Actually, many of the costs would not occur on BLM and therefore would not be reimbursable. Examples include the users survey, boater warning system, initial area cleanup, signs (BLM signs would be ordered directly from our sign shop) and costs for any road building off BLM lands.

Please let us know if you need any additional information.

Sincerely,

Jack A. McIntosh
District Manager

Edrie Vincent

December 19, 1980

Mr. Jack McIntosh, District Manager
Butte District, Bureau of Land Management
Box 3388
Butte, MT 59701

RE: Broadwater Hydroelectric Project

Dear Jack:

The Department of Natural Resources and Conservation is proposing to install a hydroelectric facility on the Toston Dam on the Missouri River in Broadwater County. As a part of this proposal DNRC is committed to the development of the appropriate level of recreational facilities. Your agency is charged with the management of lands within the project area, and we request that your cooperate with us in planning use and development. The major areas of coordination necessary will be (1) construction staging areas, (2) recreational facilities, and (3) fishing access. A response indicating your agency's decision on this request will be appreciated.

In addition to these major areas of our proposal you will be asked to review documents on the general project in the near future. Your assistance in this matter will also be appreciated.

Sincerely,

TED J. DONEY
DIRECTOR

TJD/bw
cc: Gary Fritz

F'D/WRD

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
District Office
Box 3388
Butte, Montana 59702

IN REPLY REFER TO
2300

DEC 31 1980

RECEIVED

Mr. Ted Doney
Director, DNRC
32 South Ewing
Helena, Montana 59601

Dear Mr. Doney:

As we mentioned in our letter to Edrie Vinson, dated December 12, 1980, we are very interested in cooperating with the State regarding recreation opportunities near Toston Dam. By this, we mean that we agree to work with you as closely as possible on planning and development efforts of the project, which will include construction staging areas, recreational facilities, and fishing access. However, since most discussion about the project so far has been speculative and not specific enough, we cannot make a firm commitment on the extent of the cooperation between agencies.

In addition, we are presently working on a land use planning effort for the area, which will be completed by October 1983. The proposed project will certainly be considered in the plan. Therefore, your plans will definitely have an effect on ours, and vice versa.

We intend to review any documents you send on the project and offer comments back to you as expeditiously as we can. Hopefully, we will receive these prior to our upcoming field season so that we can fit it into our work schedule easier.

There has already been considerable discussion between our agencies via phone calls and letters concerning the project. We hope our responses are what you feel you need to reach your objectives, but if not, please let us know.

Sincerely yours,

Jack A. McIntosh, District Manager
Bradley A. Brown
Acting

United States Department of the Interior

BUREAU OF LAND MANAGEMENT
District Office
Box 3388
Butte, Montana 59702

IN REPLY REFER TO
6521

1980

RECEIVED
DEC 22 1980
MONT. DEPT. OF NATURAL
RESOURCES & CONSERVATION

Mr. Fred Robinson
Montana Department of Natural Resources
32 South Ewing
Helena, Montana 59601

Dear Mr. Robinson:

As per your telephone conversation with Wayne Elliott on 12/19/80, attached is additional wildlife habitat information for the area around Toston Dam.

Sincerely yours,

Lyle G. Fox

Lyle G. Fox
Area Manager

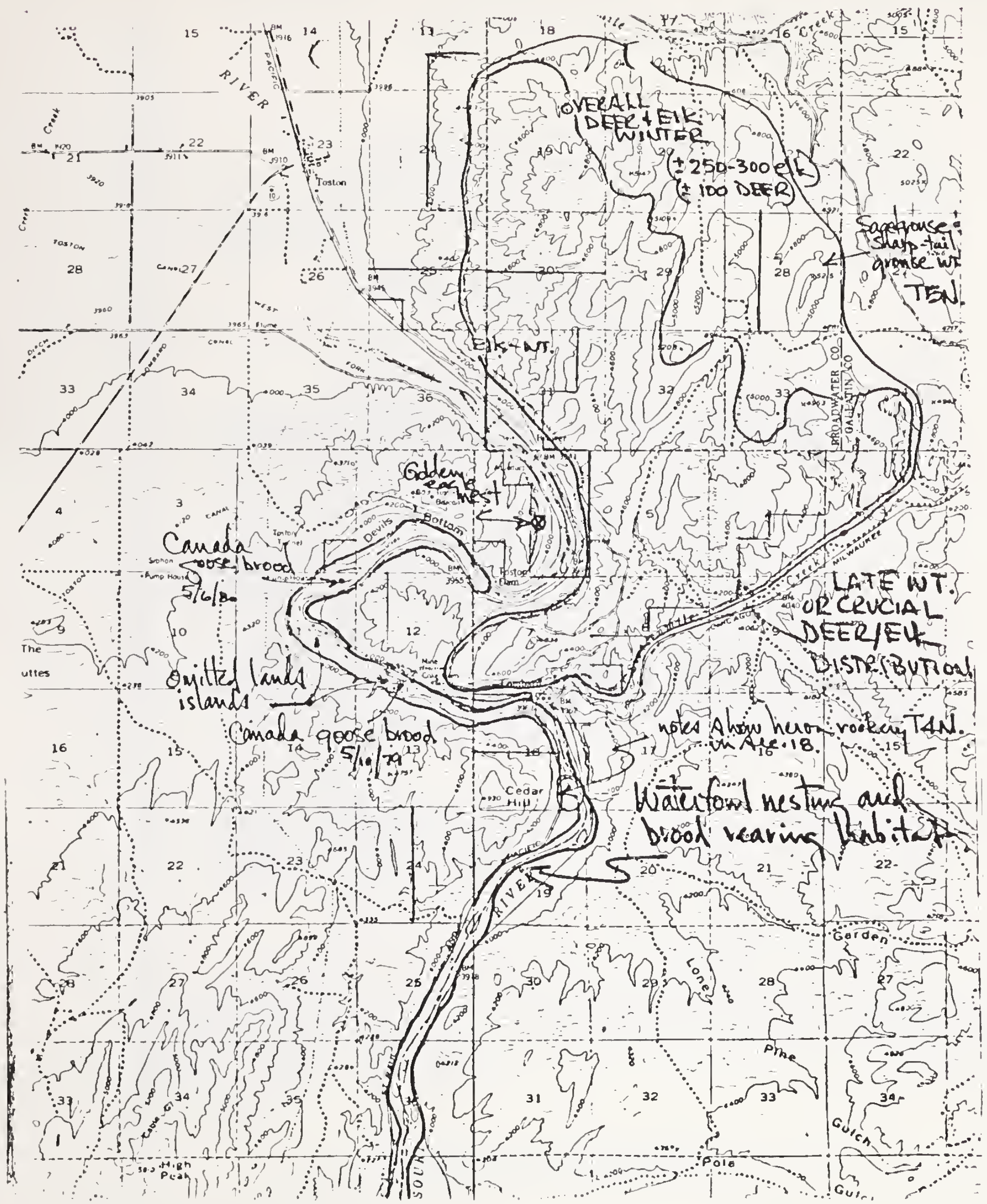
Enclosures

5/10/79, aerial survey, 1 canada goose brood observed on upstream tip of island in Section 12, T. 4 N., R. 2 E. Brood less than 1 week old, suspect nest on island.

5/6/80, riparian survey, 1 canada gooae brood observed on east side of island in NE¼NE¼ Section 11, T. 4 N., R. 2 E. Brood less than 1 week old.

6/15/80, ground survey, general observations of waterfowl, species observed include mallard, widgeon, teal, great blue heron. Suspect duck nesting in general area, aome young.

12/8/80, aerial survey, high densities of wintering mallards, common goldeneye, mergansers, etc., observed below dam for about 2.0 miles. Open water caused by dam current, springs, etc. very important to winter waterfowl habitat.



United States Department of the Interior
HERITAGE CONSERVATION AND RECREATION SERVICE
MID-CONTINENT REGION
POST OFFICE BOX 25387
DENVER FEDERAL CENTER
DENVER, COLORADO 80225

IN REPLY REFER TO:

DEC 3 1980

Ms. Edrie Vinson, Project Manager
Broadwater Hydroelectric Project
Facility Siting Division
Montana Department of Natural Resources
and Conservation
32 South Ewing
Helena, Montana 59601

Dear Ms. Vinson:

We have reviewed the information provided in your letter of November 21, 1980, on the addition of hydroelectric generators to the Broadwater Dam on the Missouri River near Toston, Montana.

Recreational facilities improvements as proposed in the plan (and described in your letter) should enhance the opportunities for recreation and also the quality of the recreational experience itself.

We are encouraged to see that consultation with local park and recreation agencies has been effected and that this consultation has resulted in good prospects for the enhancement of recreation opportunities on the site. Every effort should be made to properly replace or mitigate recreational facilities such as the picnic area and boat ramp that will be lost due to the project.

Therefore, in addition to carrying out the nine measures listed in your letter of November 21, 1980, we would also strongly recommend that any recreation facilities that are to be lost because of the project be replaced and that interpretive facilities be provided at the site which will recognize the Lewis and Clark Trail and its historic significance.

We appreciate the opportunity to provide comments.

Sincerely,

Robert J. Arkins

Robert J. Arkins
Assistant Regional Director
Land Use Coordination

DEPARTMENT OF NATURAL RESOURCES
AND CONSERVATION

THOMAS L. JUDGE GOVERNOR — 32 SOUTH EWING

STATE OF MONTANA

(406) 449-3712 — HELENA MONTANA 59601

July 24, 1980

Wally Steucke
Area Manager
U.S. Fish and Wildlife Service
316 N. 27th Street
Billings, MT 59101

Dear Mr. Steucke:

The Montana Department of Natural Resources and Conservation (DNRC) has been granted a Federal Energy Regulatory Commission preliminary permit for the installation of hydroelectric generating facilities at DNRC's existing Broadwater Dam located on the Missouri River in Broadwater County, Montana.

DNRC would appreciate your views and recommendations on the need for, content and scope of, a study of the effects that the proposed project might have on fish and wildlife resources of facilities or measures needed to conserve and develop those resources.

Your response by August 15, 1980 is necessary to complete the study requirements of the preliminary permit within the term allowed.

If you have any questions or have not seen a copy of the feasibility report for this project and would like to do so, please contact Mr. Norman Barnard (Phone: 406-449-2864). Thank you for your cooperation.

Sincerely,

Ted J. Doney

TED J. DONEY
DIRECTOR

TJD/GF/nj
cc: Gary Fritz
Norman Barnard

---

wRQ
RB
D

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
Billings Area Office
Federal Building, Room 3035
316 North 26th Street
Billings, Montana 59101

RECEIVED
AUG - 4 1980
MONT. DEPT. OF NATURAL RESOURCES & CONSERVATION

IN REPLY REFER TO:
ES

August 1, 1980

Mr. Ted J. Doney, Director
Department of Natural Resources
and Conservation
32 South Ewing
Helena, MT 59601

FERC Project No. 2853

Dear Mr. Doney:

This replies to your letter of July 24, 1980, concerning a permit to install hydroelectric generating facilities at DNRC's Broadwater Dam on the Missouri River in Broadwater County, Montana.

This project is in an area of some exceptionally fine fish, wildlife, and related environmental resources. We have conducted a preliminary reconnaissance of the area. Under provisions of the Fish and Wildlife Coordination Act, both we and the Montana Department of Fish, Wildlife, and Parks will have additional information and/or recommendations to offer as your FERC application proceeds.

Substantive issues and recommendations apparent at this time are as follows:

1. The applicant should compile and make available for review by us and Montana Department of Fish, Wildlife and Parks, hydrographs showing monthly peak, low and mean flows (in cubic feet per second) of the Missouri River at Toston, Montana, during the period of record.

2. Similarly, the applicant should describe how the proposed project would have affected hydrologic flow regimens of the Missouri River at Toston, Montana, if it had been implemented during the above period.

3. The applicant should also describe how the proposed project will affect the turbidity and movement of sediment past Broadwater Dam.

4. Additionally, the application should describe how the proposed project will alter the height of the existing dam, including the flashboards, the impoundment of water upstream of the dam, alteration or unundation of riparian habitat, and the elevation of water withdrawal from the dam.

5. Also, the applicant should describe how the proposed project will affect fishermen access, use, and boat launching facilities above and below Toston Dam.

6. The applicant should contract for or arrange to fund any studies necessary to inventory and determine the impacts on fish, wildlife, and related environmental resources so that appropriate measures can be recommended to prevent damage to or enhance these resources. This should include, but not be limited to, the potential effects of dissolved gases on fish and potential impacts of entrainment of fishes through the turbines. We believe the Montana Department of Fish, Wildlife, and Parks would be best qualified to conduct such studies.

7. The applicant should incorporate plans for construction of a fish passage structure in Toston Dam _if_ that is eventually deemed necessary as part of this project.

8. During construction, all areas of disturbed soil should be promptly graded, replanted, and cared for until good native ground cover is restored. Such land reclamation efforts should be designed to reestablish native species of grasses, forbes, and shrubs which provide cover and food sources for wildlife. In addition, special effort should be made to keep oil, gasoline, tar, asphalt, cement, biocides, sewage, sediments, refuse, and other man-made by-projects out of the river and ground water strata throughout the contract period.

9. Project power lines and associated supports should be designed and constructed to prevent electrocution of raptors. In this connection, it is noted that bald eagles and peregrine falcons pass through the area as migrants. These species are listed as endangered under provisions of the Endangered Species Act, as amended. Accordingly, FERC will be required to comply with Section 7 consultation requirements as outlined in current implementating regulations, before eventually approving a final permit.

It should also be noted that, if Corps of Engineers' permit(s) under Section 404 of Public Law 92-500 are required in connection with the project, the Fish and Wildlife Service will be required to review the

application in that connection. We may concur, with or without stipulations, or object to the proposed work depending on project effects on fish and wildlife resources which may be identified and evident at that time.

At this point, we believe that additional run-of-the-river power generation is possible at this site with little or no resulting harm to fish and wildlife if close coordination and cooperation occurs between your agency, Montana Department of Fish, Wildlife, and Parks, and the FWS. We look forward to working with you on this project.

Thank you for the opportunity to comment on this project at this early stage of planning.

Sincerely,

Wally Steucke

Wally Steucke
Area Manager

cc: FWS/ES/EC, Washington D.C.
Regional Director, USFWS, Denver, CO (ENV)
James Pozewitz, Montana Department of Fish, Wildlife, and Parks, Helena, MT
Ron Marcoux, Montana Department of Fish, Wildlife, and Parks, Bozeman, MT

DEPARTMENT OF NATURAL RESOURCES
AND CONSERVATION
WATER RESOURCES DIVISION

THOMAS L. JUDGE GOVERNOR — 32 SOUTH EWING

STATE OF MONTANA

(406) 449-2872 — HELENA, MONTANA 59601

July 28, 1980

United States Geological Survey
Mr. George Pike, District Chief
301 S. Park
Box 10076
Helena, MT 59601

Dear Mr. Pike:

The Montana Department of Natural Resources and Conservation (DNRC) has been issued a Federal Energy Regulatory Commission preliminary permit for the proposed Broadwater (Toston Dam) Hydroelectric project located on the Missouri River in Broadwater County. As a condition of this permit, the DNRC is required to contact your agency to determine what stream gages and stream-gaging stations are necessary and best adapted for the purpose of determining the stage and flow of the stream or streams affected by the Broadwater Hydroelectric Project.

The DNRC believes that the existing stations downstream of the dam and on the Broadwater main canal are adequate for this purpose. Would you please assess the stream gaging requirements of the project and respond to DNRC as soon as possible.

If you have any questions or if your have not seen and would like to see a copy of the feasibility study for the project please contact me at 449-2864. Thank you in advance for your cooperation.

Sincerely,

Norman W. Barnard

Norman W. Barnard
Hydropower Engineer
Engineering Bureau

NB/lj

United States Department of the Interior
GEOLOGICAL SURVEY
Water Resources Division
Federal Building, Room 428
301 South Park Avenue, Drawer 10076
Helena, Montana 59601

Norm —

RECEIVED
AUG 11 1980
MONT. DEPT. OF NATURAL RESOURCES & CONSERVATION

August 7, 1980

Mr. Gary Fritz, Director
Water Resources Division
Department of Natural Reaourcea
and Conaervation
32 South Ewing
Helena, MT 59601

Dear Gary:

In response to Norman W. Barnard's letter of July 28, 1980, requesting our advice on the stream gaging requirements for the proposed Broadwater (Toaton Dam) hydroelectric project, we have the following comments:

The existing streamgaging station, Missouri River at Toston, should suffice for determining the flow in the Missouri River and reflect any changes due to your proposed project. If continuous record is obtained at your gage on the Broadwater main canal and sufficient measurements are made to determine a rating for the canal, this data could be incorporated with the publication of the Toston record and should satisfy the requirements of the Federal Energy Regulatory Commission (FERC). I suggeat that if you go forward with this proposed project, that we discuss data collection and review procedures required by the FERC for the canal gage.

If you have any questions regarding this matter, please call me or Ron Shields of our Helena office.

Sincerely,

George Pike

George M. Pike
Diatrict Chief

DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION
FACILITY SITING DIVISION

THOMAS L. JUDGE GOVERNOR — 32 SOUTH EWING

STATE OF MONTANA

(406) 449-4600 — HELENA MONTANA 59601

December 19, 1980

Mr. Tom DeWitt
Project Manager
Federal Energy Regulatory Commission

RE: Broadwater Hydroelectric Project #2853
Montana Department of Natural Resources and Conservation

Dear Tom:

We have completed our cultural resource inventory of the reservoir area and proposed pool increase which we believe are eligible for listing on the National Register of Historic Places. Enclosed you will find documentation on these two properties, and the comments of the Montana State Historic Preservation Office.

Please forward one copy of this information along with your request for a determination of eligibility to:
Mr. Jerry Rogers
Acting Keeper of the National Register
Heritage Conservation and Recreation Service
440 G Street NW
Washington, DC 20243

Please advise us of the Keeper's decision on the eligibility of these properties in order that we may complete part 4 of Exhibit E on our project application in an expeditious manner.

Thank you for your assistance.

Sincerely,

Edrie Vinson

Edrie Vinson, Project Manager
Broadwater Hydroelectric Project
Facility Siting Division
Department of Natural Resources
& Conservation

EV/sb

Enclosures

DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION
FACILITY SITING DIVISION

THOMAS L. JUDGE GOVERNOR — 32 SOUTH EWING

STATE OF MONTANA

(406) 449-4600 — HELENA MONTANA 59601

December 19, 1980

Mr. Burt Williams Archaeologist
Bureau of Land Management
Billings, MT 59601

RE: Antiquities Permit
Broadwater Hydroelectric Project #2853

Dear Burt;

Department of Natural Resources and Conservation has completed the survey and testing program on the Missouri River-Toston Dam reservoir area, and now we wish to share the results with you. While we did not identify sites on BLM lands you will find the information relevant to future survey work in the area.

Assuming that 24BW182 is determined eligible as requested, we propose to conduct excavations at the site if our hydroelectric project is implemented. In this event we again will be pleased to share our information in turn for any suggestions, comments, or assistance you can offer.

Thank you so much for expediting the permit application for us. I hope this fulfills our responsibilities under the permit. If not, please advise me.

Sincerely,

Edrie Vinson

Edrie Vinson, Project Manager
Broadwater Hydroelectric Project
Facility Siting Division
Department of Natural Resources
& Conservation

EV/sb

Enclosure

STATE OF MONTANA

DEPARTMENT OF
FISH AND GAME
1420 East Sixth Avenue
Helena, Montana 59620
February 4, 1982

Mr. Leo Berry, Director
Montana Department of Natural
Resources and Conservation
32 South Ewing
Helena, Montana 59620

Dear Leo:

During the last few months there have been meetings between our Departments regarding recreational facilities at Toston Dam. The purpose of this letter is to clarify the Department of Fish, Wildlife and Parks' position on recreation development at the dam.

Basically, our Department feels that recreation measures and facilities are necessary for the purpose of preserving the existing recreational opportunities at the project. We feel that the Toston Dam area has outstanding recreation opportunities and has served the public for many years. Existing access to the area, both above, below and across the dam should be perpetuated in the future.

The Department's position is that the DNRC should perpetuate the opportunities that serve the recreating public. The DNRC should take positive steps to see that these opportunities remain. These steps should include graveling roads, parking, and boat access, both above and below the dam, and providing latrines and picnic tables for the recreationists.

Our Parks Division staff is available to consult with your Department if you need technical information concerning the design and construction of the facilities. If you have any comments, do not hesitate to contact me.

Sincerely,

Jim

James W. Flynn
Director
Department of Fish, Wildlife and Parks

JWF/RM/sk
cc: Dick Mayer
Larry Peterman
Rick Bondy
LeRoy Ellig

STATE OF MONTANA

DEPARTMENT OF

FISH AND GAME
Helena, Montana 59620
January 6, 1981

Mr. Leo Berry, Director
Department of Natural Resources and
Conservation
32 S. Ewing
Helena, Montana 59620

Dear Mr. Berry:

In July 1980, the Department of Natural Resources and Conservation (DNRC) requested the Department of Fish, Wildlife and Parks (DFWP) views and recommendations on the need for and content and scope of, a study of the effects that the proposed Broadwater Hydroelectric Project might have on fish and wildlife resources and of facilities or measures needed to conserve and develop those resources.

The DFWP response of August 7, 1980, identified the necessity of determining the appropriate instream flow for that reach of river. Subsequent consultations and meetings regarding the project revealed that instream flows would not be altered and hence such determination would not be necessary for this project. However, these same consultations and meetings identified other areas of potential impacts.

Based on additional knowledge of the project, and these potential impacts, the DFWP reassessed their views and recommendations and through additional discussions with the DNRC have developed a study proposal which will identify the effects that the proposed project might have on fish and wildlife resources and the facilities or measures needed to conserve and develop those resources.

DFWP has been informed by DNRC of their desire to develop this project as expeditiously as possible. DFWP understands that time required to complete the proposed study is beyond the time scheduled for submission of the FERC License application. Also, DNRC does not have funds appropriated at this time to finance the study. In the interest of not delaying the development of the project, the DFWP will not object to the submission of a FERC license application or the issuance of that license, provided the proposed study (copy attached) will be made a condition of the FERC License when it is issued, and a reasonably firm commitment is made to implement proper compensation for wildlife values lost to the project.

The DNRC has worked cooperatively with the DFWP on this project, and DFWP feels that this approach will meet the goals of both agencies, will not unduly delay the project, and will allow DNRC to finance the study and reasonable recommendations resulting from the study.

Please keep us advised as to the status of the FERC License application when it is submitted.

Sincerely,

James W Flynn

James W. Flynn, Director

JWF/mac

STATE OF MONTANA

DEPARTMENT OF FISH, WILDLIFE AND PARKS

RECEIVED

1980

Office Memorandum

TO : Edric Vinson

DATE: 12/17/80

FROM : Larry Peterman

SUBJECT: Toston Dam

Attached are memos from our wildlife biologist stationed in Townsend (Jeff Herbert) and Bob Martinka concerning wildlife values in that portion of the Missouri River upstream from Toston Dam. Their analyses is qualitative and based on the assumption that a rise in pool elevation would be associated with the addition of a turbine at Toston dam. A better estimate of impacts can be made with a more precise outline of the new flood pool elevation.

LGP/mac

DEPARTMENT OF FISH, WILDLIFE AND PARKS

Office Memorandum

TO : Larry Peterman

DATE: 12/15/80

FROM : Bob Martinka

SUBJECT: Toston Dam

On November 6, 1980 Jim Posewitz and I inspected the Toston Dam area to get a general idea of the potential impacts of raising the dam height so that it could accommodate hydropower production. Our inspection was by means of a motor propelled boat which we launched at the existing dam. We proceeded upstream about 3 miles to a large island with an old cabin located in the middle of it. At the time of our inspection, the water level was several feet lower than the facility is apparently operated during the irrigation season, exposing mud and gravel bars around the islands and shoreline. There were numerous stakes along the shoreline which apparently indicated the level of the pool for the new dam that had been proposed at that time. It is our understanding that proposed elevations may have been changed subsequent to our inspection.

The 3-mile portion of the pool area which we inspected contains three major island complexes and a number of shoreline areas with similar vegetative development. Basically, the west side of the river consisted mostly of steep banks with little riparian vegetation development. The east bank consisted of sediment deposition areas, most of which were vegetated with an abundance and variety of riparian vegetation. The railroad grade formed the river border in areas with sediment buildup. The island complexes had vegetation similar to the shoreline. Again, these areas were extremely diverse vegetatively, with communities ranging from cattails, sedges and bullrushes to cottonwood, willow and dogwood to snowberry and rose.

Indications from the shoreline stakes were that virtually the entire 3-mile area we inspected would be flooded. Because of the channel configuration of steep banks on one side and a railroad grade on the other, it would be many years before enough sediment accumulated for riparian-type vegetation to again appear in this area and upstream for probably a significant additional distance.

Our inspection revealed that this area presently supports a tremendously diverse assemblage of furbearing animals, including beaver, muskrat, raccoon, mink and otter. Habitat for all these species would be eliminated.

Pheasants and white-tailed deer also occur in the area, but neither is overly abundant. Of more importance are waterfowl production and use in the area. A memo from Jeff Herbert, the area biologist, outlining this situation is attached. Obviously, habitat for Canada geese and also hunting opportunities will be lost.

STATE OF MONTANA

DEPARTMENT OF FISH, WILDLIFE AND PARKS

RECEIVED
DEC 12 1980
ENVIRON. RESOURCES

Office Memorandum

DATE: 12-10-80

TO : Bob Martinka

FROM : LeRoy Ellig By: Jeff Herbert

SUBJECT: Wildlife considerations related to proposed increase in storage capacity and power generation of Toston Dam.

Waterfowl Use:

Canada Geese - Area can be used during the entire year. The spring nesting and early summer brood rearing periods are probably the most critical. Spring breeding pair surveys have documented the following use by geese on the section of the Missouri River from Toston to Clarkston. These flights were made in late April to early May.

Year	Pairs	Singles	Groups	Total
1980	15	10	3	43
1979	11	3	13	38
1978 1/	21	10	20	72
1977	13	6	7	39
1976	7	7	13	34

1/ Included area from Toston to Trident.

Childress felt that the upper portion of this survey section was probablv more important in terms of nest density than the lower pool area. Increased water levels would or could flood existing islands and grazing areas adjacent to the river. This would prove to be very detrimental to this segment of the resident goose flock.

Ducks - Only documentation has been the fall migration flights and the mid-winter census. One would expect to find nesting ducks (primarily mallards) in this area. We may want to schedule some type of census/search next spring. The stands of emergent vegetation should provide secure brood rearing areas and offer potential nest sites for coots, grebes and possibly rails (Sora). Existing gravel bars and islands offer secure loafing areas.

Furbearers:

No documented data. Beaver, muskrat and mink are probably fairly common in this section of the river. Otter are present. Beaver are dependent on the woody riparian growth and muskrats on the emergent vegetation. Both vegetation types would be adversely impacted by higher water levels.

Upland Game Birds:

Primarily pheasants. Pheasants become more common in the Clarkston area as opposed to the lower pool area. Their distribution is related to both agriculture (small grain production) and secure woody cover. The extent to which this woody cover is impacted should be an important consideration.

JH/kdb

STATE OF MONTANA

DEPARTMENT OF FISH, WILDLIFE AND PARKS

RECEIVED
NOV 24 1980
MONT. DEPT. OF NATURAL RESOURCES & CONSERVATION

Office Memorandum

TO : Toston Dam File

DATE: Nov. 20, 1980

FROM : Richard Mayer R. Mayer

SUBJECT: Field Trip on Nov. 19, 1980

On this date, Stewart Allen, Phil Maechling, and myself visited the Toston Dam area to examine the existing recreation patterns and possible future patterns of the area.

It was evident that the area was extremely over-used with little maintenance beind done to the area. Two single latrines exist along the canal direclty below the dam. Both are beat up and in a condition that warrants their removal from the site. A picnic table exists directly below the dam and is in poor condition. It should also be removed from the site. Other facilities have been completely destroyed through the years leaving no physical recreational improvements in the area. People are able to park below the dam, adjacent to the river, and above the dam to put in and take out boats. Very little vegetation remains on these use areas. There are some signs warning the user of the danger of currents directly below the dam but it is an extremely popular place for fishing.

If the reservoir is raised three feet this will impact the recreation above the dam. At this time, people put their boats in or take them out from floats upstream at a small turn-around area within about 300 feet of the dam. With this area gone, an additional area (property directly west of the existing site) should be obtained from the Bureau of Land Management. In this area, parking would be available and some day use facilities could be installed, such as picnic tables, grills, and a double seal vault latrine. Barriers would be needed to keep vehicles on the surfaced areas and signing would be required to identify basic rules and regulations.

Below the dam the area is so tight that any improvements would be quite minimal. Some surfacing needs to be done and parallel parking needs to be encouraged adjacent to the river's edge. A new double latrine and a fiberglass sealed vault should be installed for comfort of the user. Additional expansion in the future could be encouraged at a site about a mile downstream from the dam in an old gravel borrow area.

For rough cost estimating purposes, I have prepared the following:

1.	Double latrines	about $8,000.00/ea.
2.	Gravel surfacing and road improvement	about .40/sq. ft.
3.	Barriers	about 21.00/ea.
4.	Fencing	about 16.00/rd.
5.	Water wells	about 4,000.00/ea.

6.	Picnic tables	about $250.00
7.	Fire rings	about 200.00
8.	Garbage cans	about 200.00
9.	Miscellaneous signs for the area	about 500.00

Additional impacts on fisheries and wildlife were not examined in this trip but I feel they do need attention if a complete comprehensive appraisal is to be made of the impacts of any proposed alterations to the reservoir.

RM:an

cc: Larry Peterman
Stewart Allen
Phil Maechling

STATE OF MONTANA

DEPARTMENT OF

FISH AND GAME

8695 Huffine Lane
Bozeman, MT 59715

November 14, 1980

Stewart Allen
Utilities Siting Division
Dept. of Natural Resources & Conservation
32 South Ewing
Helena, Montana 59601

Stewart:

The following is to follow-up our phone conversation on November 3 concerning the Dept. of Fish, Wildlife and Parks recreational land holdings on the Missouri River between the Headwaters and Canyon Ferry Reservoir.

Toston Fishing Access Site

Toston F.A.S. is 36.62 acres and was acquired in April of 1978. The only improvement on the site now is a boat launching ramp. The only possible improvements in the near future are installation of sanitary facilities and possible leveling and cleaning of some of the land.

No traffic count has been established for this area.

Deepdale F.A.S.

Deepdale is approximately 15.5 acres and has picnic and camping facilities, latrines and a boat ramp. Its current primary use is as a day use fishing access.

From May 24 to Sept. 30, 1980, *1098 vehicles used this site.

There is no planned development in Deepdale.

Indian Road F.A.S.

Indian Road is used as a day fishing access site as well as an overnight camping area. It has picnic and camping facilities, latrines and a boat ramp.

From May 24 to Sept. 30, 1980, *1958 vehicles used this site. In the 1980 summer season, 12 overnight camping permits were sold as opposed to the '79 season when 30 permits were sold.

There is no development planned for Indian Road.

Fairweather F.A.S.

Fairweather F.A.S. is 625 acres and has minimal development--a small parking lot and boat ramp. On the access site sits the old town of Clarkston consisting of a schoolhouse, general store and several other frame buildings. Its current uses are for fishing, hunting and some camping and picnicking.

In a 94 day period in the summer of 1980, *411 vehicles used this site.

Resource development will be minimal at Fairweather but may include site improvements such as latrines and picnic areas, also preservation of the Clarkston buildings.

Missouri River Headwaters State Park

At the Headwaters there are 527 acres of park land housing a boat ramp, picnic area, interpretive displays and several fishing access sites.

The site has no traffic count data available, however, camp permits are sold. From June 1-August 30, 1980, 1050 permits were sold. It is worthy to note however, that only a small percentage of the park users also use the campground, therefore, actual park use figures would be many times that of the permits sold.

Little further development is planned at the Headwaters.

*It is worthy to note that the traffic count data is only for the highest use period of the year, therefore counts should be increased 15% to give an estimation for a total year's use.

Well that's about it for our sites. If you need additional information, feel free to give me a call.

Sincerely,

LEROY ELLIG
REGIONAL SUPERVISOR

Doug Monger/jd

Doug Monger
Parks Manager I

LE:DM:jtb

DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION

THOMAS L. JUDGE GOVERNOR — STATE OF MONTANA — 32 SOUTH EWING

(406) 449-3712 — HELENA, MONTANA 59601

July 24, 1980

Keith Colbo, Director
Department of Fish, Wildlife & Parks
1420 East Sixth Avenue
Helena, MT 59601

Dear ~~Mr. Colbo~~ Keith:

The Montana Department of Natural Resources and Conservation (DNRC) has been granted a Federal Energy Regulatory Commission preliminary permit for the installation of hydroelectric generating facilities at DNRC's existing Broadwater Dam located on the Missouri River in Broadwater County, Montana.

DNRC would appreciate your views and recommendations on the need for, content and scope of, a study of the effects that the proposed project might have on fish and wildlife resources of facilities or measures needed to conserve and develop those resources.

Your response by August 15, 1980 is necessary to complete the study requirements of the preliminary permit within the term allowed.

If you have any questions or have not seen a copy of the feasibility report for this project and would like to do so, please contact Mr. Norman Barnard (Phone: 406-449-2864). Thank you for your cooperation.

Sincerely,

Ted J. Doney

TED J. DONEY
DIRECTOR

TJD/GF/nj
cc: Gary Fritz
Norman Barnard

WRD

STATE OF MONTANA

DEPARTMENT OF FISH AND GAME

RECEIVED
AUG 13 1980
MONT. DEPT. OF NATURAL RESOURCES & CONSERVATION

1420 East Sixth Avenue
Helena, MT 59601
August 7, 1980

Ted J. Doney
Department of Natural Resources
and Conservation
Helena, MT 59601

Dear Ted:

I have received your letter of July 24, notifying us that the DNRC has been granted a Federal Energy Regulatory Commission preliminary permit for the installation of hydroelectric generating facilities at Broadwater Dam located on the Missouri River in Broadwater County.

In response to your specific request for a scope of the study from the effects of that project, we advise that an exceptional fish and wildlife resource exists on the Missouri River through that particular section. The key to protecting and enhancing that resource will be the amount and pattern of instream flows that will occur from Broadwater Dam to Canyon Ferry Reservoir. It is therefore our feeling that any evaluation of this proposed project must, of necessity, include identifying the appropriate instream flow for that reach of river. I certainly urge that appropriate financial resources be made available to our department to make that evaluation.

Sincerely,

Fletcher E. Newby, Acting

Keith L. Colbo
Director

KLC/JP/mac

cc: Larry Peterman
LeRoy Ellig

DEPARTMENT OF NATURAL RESOURCES
AND CONSERVATION
FACILITY SITING DIVISION

THOMAS L. JUDGE GOVERNOR — 32 SOUTH EWING

STATE OF MONTANA

(406) 449-4600 — HELENA, MONTANA 59601

December 19, 1980

Marcella Sherfy
Deputy State Historic Preservation Office
225 North Roberts
Helena, MT 59601

RE: Broadwater Hydroelectric Project #2853

Dear Marcella:

The Department of Natural Resources and Conservation proposes to construct a hydroelectric facility on the existing Toston Dam in Broadwater county. As a result of this proposal the Facilities Siting Division is preparing an "Exhibit E" to accompany the states application for a liscence to the Federal Energy Regulatory Commission. This Exhibit E is to contain evidence of our consultation with your office relative to the Historic preservation Act and 36CFR800.

By way of this letter we are submitting the report of our survey and our documentation to facilitate requests for determination of eligibility for listing on the National Register of Historic Places for sites 24BW180 and 24BW182. As the other sites mentioned in the survey report are outside the project area, (i.e. Lombard and 24BW181) or could not be relocated, (24BW570) we are not requesting determination of eligibility for them. The houses at the dam site were constructed in the 1950's and are therefore not considered as potentially eligible. The Ellis Island cabin site is altered by modern building materials, and research failed to identify historical significance of the site or owner. We were not able to visit the site due to the extensive mud flats surrounding it at the time of survey, and we do not believe it merits further attention. At the time our survey report was written we did not know if Ellis Island would be flooded by the project. Now we know that it will not be inundated, and the water level will be increased by approximately four inches at that point.

"Exhibit E" also requires a plan for any mitigation, a schedule for completion, and indication that sufficient funds are available for the mitigation. We are proposing a no adverse effect by reason of data recovery on site 24BW182. If you concur in our opinion that the site is eligible and does meet the criteria for no adverse effect, we request that you also comment on our mitigation proposal and budget.

In addition to "Exhibit E" we are preparing a Preliminary Environmental Review (PER) as an in-house decision making document. As this PER contains a description of the project which is not found in the "Exhibit E", we will forward it to you for your information to assist you in reviewing "Exhibit E." Both documents are scheduled for review early in January.

Your expedient review will be greatly appreciated.

Sincerely,

Edrie Vinson

Edrie Vinson, Project Manager
Broadwater Hydroelectric Project
Facility Siting Division
Department of Natural Resources
and Conservation

EV/sb

Enclosures

MONTANA HISTORICAL SOCIETY
HISTORIC PRESERVATION OFFICE
225 NORTH ROBERTS STREET • (406) 449-4584 • HELENA, MONTANA 59601

December 29, 1980

RECEIVED

Ms. Edrie Vinson, Project Manager
Broadwater Hydroelectric Project
Facility Siting Division
D.N.R.C.
32 South Ewing
Helena, MT 59620

Dear Edrie:

Re: Broadwater Hydroelectric
Project #2853

Thank you for the opportunity to review the exhibit prepared for the above-named proposed undertaking. I believe that archaeological site 24BW182 is a Montana Heritage property in that it is significant in American prehistory. Furthermore, this property is probably eligible for listing on the National Register of Historic Places. Its eligibility is primarily determined by the information it can potentially yield on Great Plains prehistory. More particularly, information on chipped stone tool technology, subsistence, altithermal environmental reconstructions, cultural continuity, and prehistoric settlement can be gained by careful excavation and analysis of the remaining cultural deposits.

I also agree that the Lombard Coke Oven Site (24BW180) is eligible as a Montana heritage and a National Register property. The site is clearly significant for its association with early coal production and its economic impact in that county and as a distinctive illustration of structural types, buildings and structures that were needed for coal mining and coke manufacturing. Although many structures in the area are now gone, the coke ovens retain a high degree of integrity. I recommend that prior to submission to the National Register that the site boundaries be more precisely defined and a sketch map drawn of the features in the site.

We also recommend that the Ellis Cabin Site be documented with a site number and form when possible, even prior to anticipated impacts.

If you have not done so, I urge you to investigate whether or not you can act for the Federal Energy Regulatory Commission in seeking a determination of eligibility or undertaking project evaluation with the Advisory Council in Historic Preservation. To our knowledge the Department of Housing and Urban Development is the only Federal agency that has made formal arrangements for the delegation of responsibilities in this matter. I anticipate commenting on mitigation after determinations of eligibility and effect have been made.

Sincerely,

Marcella Sherfy

Marcella Sherfy
Deputy SHPO

TAF/MS/det

DEPARTMENT OF NATURAL RESOURCES
AND CONSERVATION
WATER RESOURCES DIVISION

THOMAS L. JUDGE, GOVERNOR
32 SOUTH EWING
STATE OF MONTANA
(406) 449-2872
HELENA, MONTANA 59601

RECEIVED
DEC 10 1980
MDHES
DIRECTOR'S OFFICE

December 9, 1980

Montana Department of Health &
Environmental Sciences
Cogswell Building
Capitol Station
Helena, MT 59601

Dear Sir:

The Department of Natural Resources and Conservation is applying for a Federal Energy Regulatory Commission License for the Broadwater Hydroelectric Project. As a requirement of this application, we must include a copy of a water quality certificate (or statement that such certification is waived) as described in Section 401 of the Federal Water Pollution Control Act.

Based on initial discussions with personnel of the DHES, a certificate can not be issued at the stage of design this project is presently at. DNRC would appreciate a letter from the DHES confirming this. DHES may also want to request that the certificate or waiver be included as a condition of the FERC License when it is issued.

DNRC believes that this is a reasonable solution to the requirements of the FERC License application and will prevent the delay of the project which will occur if the actual certificate or waiver is required prior to the issuance of the license.

Sincerely,

Norman W. Barnard

Norman W. Barnard
Hydropower Engineer
Engineering Bureau
(406) 449-2864

NB/lj

RECEIVED
DEC 10 1980
MDHES
Environmental Sciences Div.

Route to:
A. Knight
J. Bartlett

To Don W + Steve

DEPARTMENT OF HEALTH AND ENVIRONMENTAL SCIENCES
WATER QUALITY BUREAU

STATE OF MONTANA

December 19, 1980

Norman Barnard
Engineering Bureau
Water Resources Division DNRC
32 South Ewing St.
Helena, MT 59601

Dear Mr. Barnard:

I have enjoyed our discussions of the prospective Broadwater Hydroelectric project. In this letter I will summarize some of the concerns we have discussed about this project.

The Missouri River at the project site is classified as a B-1 stream and is one of the better trout fisheries in the state. I have attached a copy of the state water quality standards which list the other beneficial uses of this reach of the Missouri River. Because there is an existing dam at the site the project's impacts on the beneficial uses should not be significant. However the Department of Health feels that there is a possibility of damage both during construction (primarily increased sediment) and from the operation of the project from super saturation with gases due to design features). We feel the probability of damage is not great, nonetheless because the possibility exists we hope we will be kept informed about the construction and design features of the projects.

We will be glad to evaluate the construction plans and the design features to determine their impact on water quality.

Sincerely,

Abe Horpestad, Ph.D.
Water Quality Bureau

AH/bb

Attach:

DEPARTMENT OF HEALTH AND ENVIRONMENTAL SCIENCES
WATER QUALITY BUREAU

THOMAS L. JUDGE, GOVERNOR

STATE OF MONTANA

(406) 449-2406

December 17, 1980

Norman W. Barnard
Hydropower Engineer
Engineering Bureau
Water Resources Division
Department of Natural Resources
32 South Ewing Street
Helena MT 59601

Re: Broadwater Hydroelectric Project
Water Quality Certification

Dear Mr. Barnard:

In confirmation of earlier correspondence regarding the water quality certification necessary for processing of the FERC license for the Broadwater Hydroelectric Project, this Department is unable to issue such certification at this time. Clearly this does not reflect a desire either to deny or grant certification at this time, but rather, this Department's position that the information available at this stage of design will not allow an informed decision regarding compliance with the Montana Water Quality Act, Standards and other rules related to water pollution control in Montana.

Obviously, this Department does not wish to waive its right of certification, but suggests that the requirement for "water quality certification" be approached at a later design stage, and prior to issuance of a FERC license.

Thank you for your consideration in this matter. Please contact Mr. Abe Horpestad or me at (406) 449-2406 if you have any questions or comments.

Sincerely,

Kevin D. Keenan

Kevin D. Keenan
Permits/Enforcement
Water Quality Bureau
Environmental Sciences Division

KDK/as
cc: Horpestad, Water Quality Bureau

DEPARTMENT OF NATURAL RESOURCES
AND CONSERVATION
FACILITY SITING DIVISION

THOMAS L. JUDGE, GOVERNOR

32 SOUTH EWING

STATE OF MONTANA

(406) 449-4600

HELENA, MONTANA 59601

MEMORANDUM

Notes from Meeting with the Broadwater County Commissioners
Broadwater County Courthouse

BY: Edrie Vinson, Project Manager
Kootenai Falls
Projects Bureau (PB)
Facility Siting Division (FSD)
Department of Natural Resources & Conservation (DNRC)

David W. Ford, Assistant Project Manager
Kootenai Falls
PB
FSD
DNRC

DATE: November 7, 1980

RE: Broadwater Hydroelectric Project No. 2853, Environmental Report

The Commissioners informed us they had already gone on record favoring construction of hydroelectric facilities on the Broadwater Dam. We asked if they had any specific concerns which we should address in our review. They had no major concerns about project impacts, but we discussed several matters they wished to have addressed.

Early in the 1960's an again in 1979 there was water in the pump house for the irrigation tunnel, and it had to be shut down to prevent damage to the motors. Mrs. Ward Scofield, Broadwater Irrigation Project, would have details of high water problems. The Commissioners expressed concern that the project would worsen the flooding situation.

Debris coming downstream has always been a problem. The project should be designed to deal with it. Also, the side planks have been left in during the draw down to insure the dam doesn't wash out at the sides. This should also be considered in the design.

The Commission believed that to raise the water level three (3) feet would be beneficial to the irrigation system. To date there has always been sufficient water to operate the system. They expressed concern that the increase might interfere with the goose nesting on the islands, and asked that we check on the possibility.

There may also be a man living in the cabin on the island above the bend. He has used the island for putting up hay. The Commissioners asked that we determine if the island would be flooded, and if the man was still there.

We informed the Commissioners that the DNRC planned to have the project contractors maintain the road by grading, filling, dust abatement. They agreed this would be sufficient, but asked that we use water, not oil. They have no facilities to maintain an oil road there. The road is currently a declared gravel county road. The canal seeps onto the road during irrigation season, and maintenance can be a problem.

We discussed the recreational value of the Broadwater Dam area, and the Commissioners told us the site provided excellent fishing and recreational floating. They wish to see these values protected and enhanced. There is no serious parking problem now, but 25 to 30 cars are there daily with 40 to 50 on weekends. Off-road parking would be desirable. There are no overnight campter facilities, but campers frequent the area. Such a designated area is desired. The toilet facilities are inadequate, and they wish to have them replaced. The bend between the ditch and the river should be made into a picnic area. They do not want boat ramps constructed which would facilitate and therefore encourage the use of motor boats in the area. They do, however, wish to facilitate floater access. While there is no record of floater accidents with the project as it now stands, the Commissioners believe the hydropower facility warrants a floater warning and a guard rope.

We discussed the gold mining claim and told the Commissioners we would check on the water quality if the area would be flooded by the project. It appears the settling pond would be flooded if the water level were increased by three (3) feet.

The Commissioners expressed concern for local employment, and suggested contractors be required to give priority to local persons applying for employment on the project. They do not have contractors large enough to handle the project construction, but wish to stipulate that local subcontractors be utilized as available.

The Commissioners anticipate no social problems as a result of the influx of construction workers. We reported ten (10) to 15 workers the first six (6) months, 30 workers the second (2nd) months, and five (5) to ten (10) workers the last six (6) months.

The Commissioners informed us of a local sand and gravel operation near Toston. The firm, Barney Johnson, could supply the project if given sufficient advance notice.

The Commissioners expressed their desire to see the power go to the Vigilante Co-op.

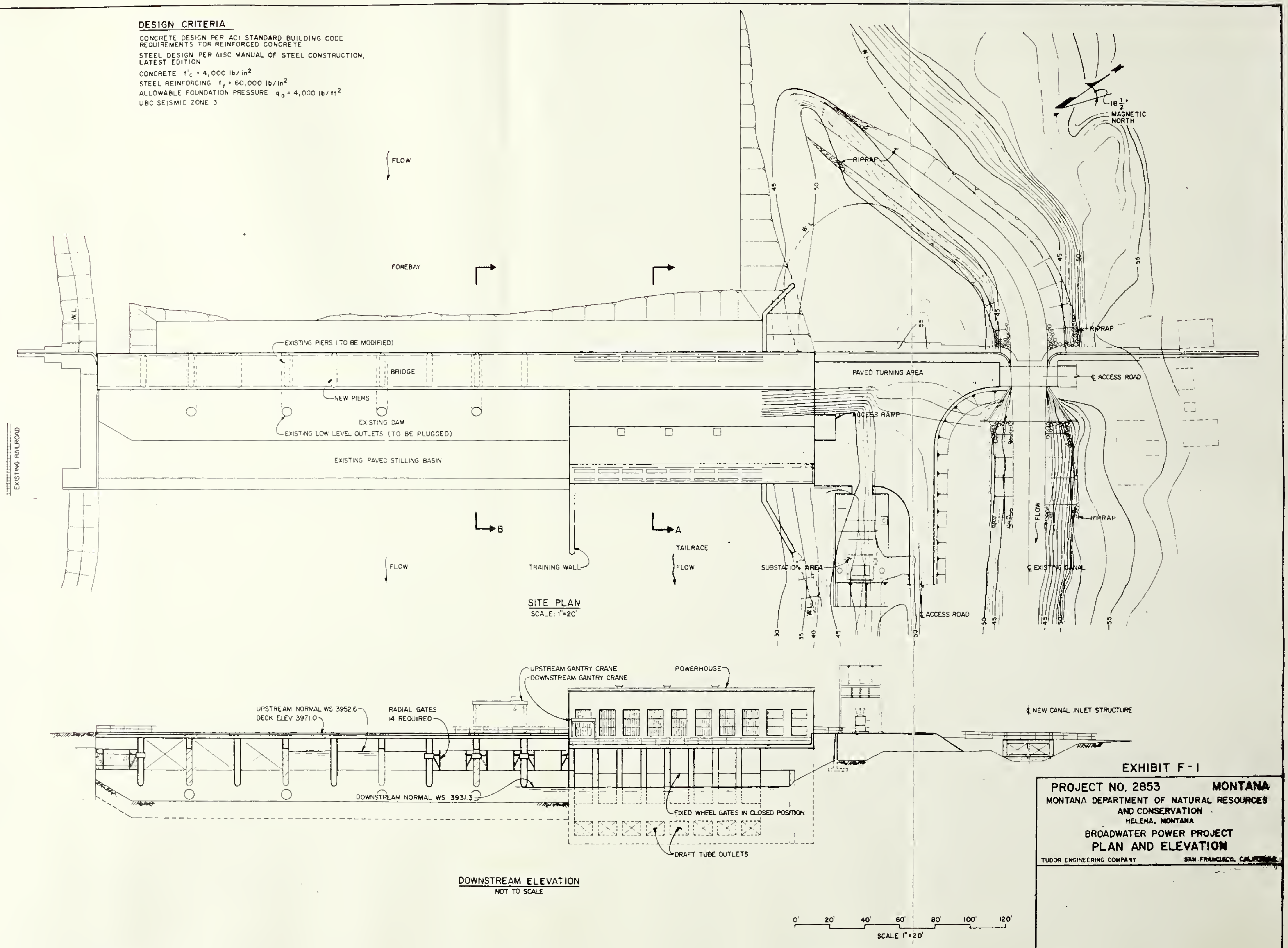
We told the Commissioners we would report their concerns to our office, and bring our draft reports for them to review in early December.

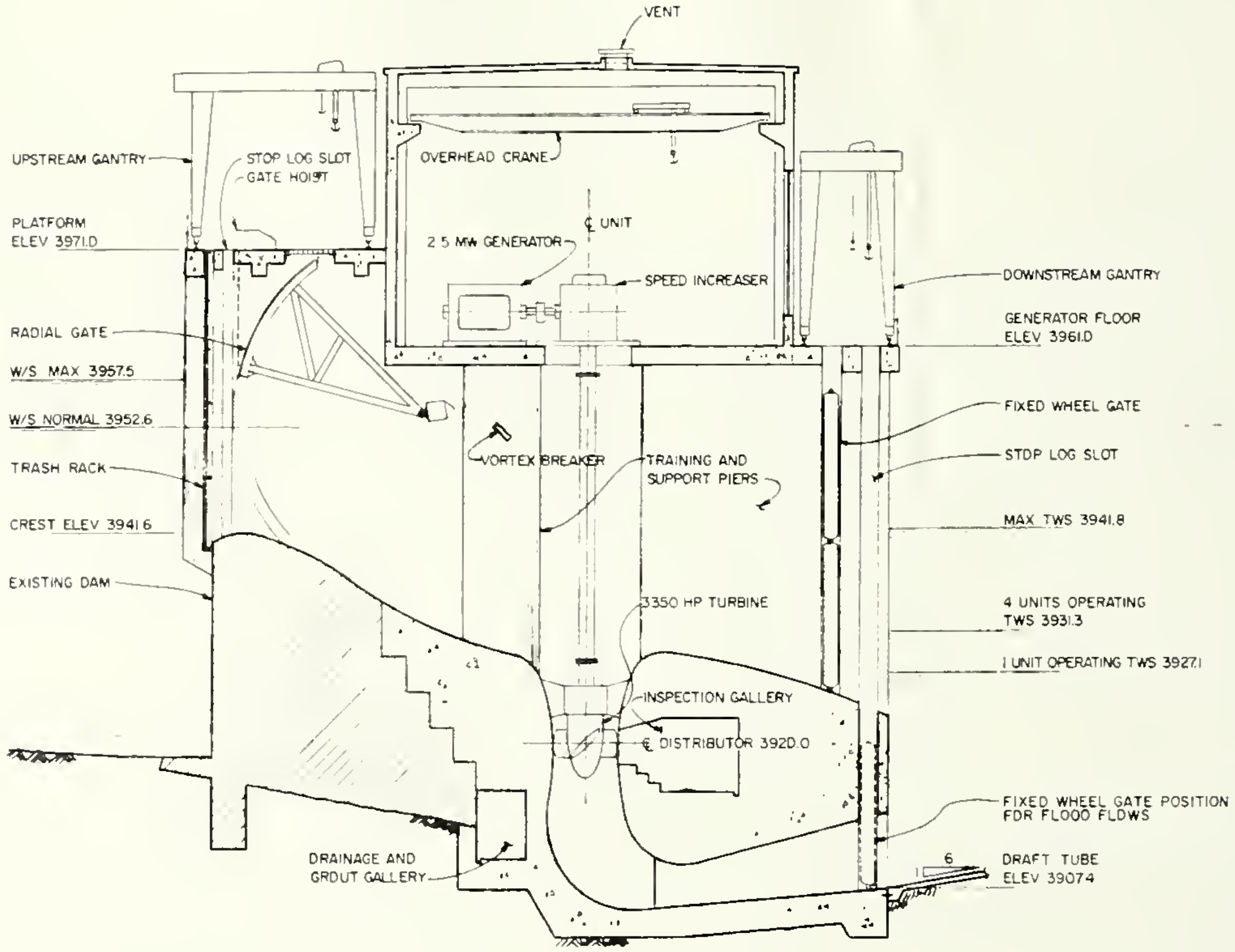
EV/cab

cc: Norm Barnard
Water Resources Division
Department of Natural Resources
& Conservation

EXHIBIT F

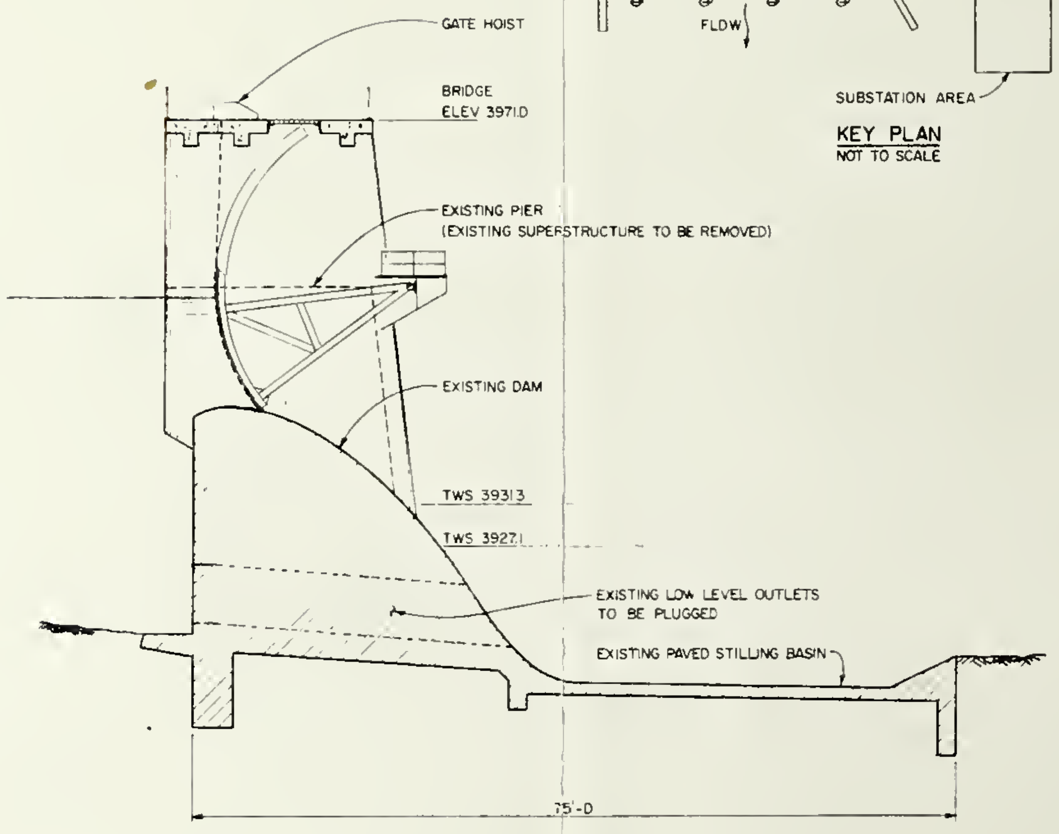
DESIGN DRAWINGS


DESIGN CRITERIA:
CONCRETE DESIGN PER ACI STANDARD BUILDING CODE REQUIREMENTS FOR REINFORCED CONCRETE
STEEL DESIGN PER AISC MANUAL OF STEEL CONSTRUCTION, LATEST EDITION
CONCRETE f'_c = 4,000 lb/in^2
STEEL REINFORCING f_y = 60,000 lb/in^2
ALLOWABLE FOUNDATION PRESSURE q_a = 4,000 lb/ft^2
UBC SEISMIC ZONE 3
FLOW
FOREBAY
W.L.
EXISTING PIERS (TO BE MODIFIED)
BRIDGE
NEW PIERS
EXISTING DAM
EXISTING LOW LEVEL OUTLETS (TO BE PLUGGED)
EXISTING PAVED STILLING BASIN
EXISTING RAILROAD
B
A
TRAINING WALL
TAILRACE
FLOW
SITE PLAN
SCALE: 1"=20'
RIPRAP
$18\frac{1}{2}°$
MAGNETIC NORTH
PAVED TURNING AREA
℄ ACCESS ROAD
ACCESS RAMP
SUBSTATION AREA
℄ ACCESS ROAD
℄ EXISTING CANAL
UPSTREAM GANTRY CRANE
DOWNSTREAM GANTRY CRANE
POWERHOUSE
UPSTREAM NORMAL WS 3952.6
DECK ELEV 3971.0
RADIAL GATES
14 REQUIRED
DOWNSTREAM NORMAL WS 3931.3
FIXED WHEEL GATES IN CLOSED POSITION
DRAFT TUBE OUTLETS
℄ NEW CANAL INLET STRUCTURE
DOWNSTREAM ELEVATION
NOT TO SCALE
0' 20' 40' 60' 80' 100' 120'
SCALE 1"=20'
EXHIBIT F-1
PROJECT NO. 2853 MONTANA
MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION
HELENA, MONTANA
BROADWATER POWER PROJECT
PLAN AND ELEVATION
TUDOR ENGINEERING COMPANY SAN FRANCISCO, CALIFORNIA



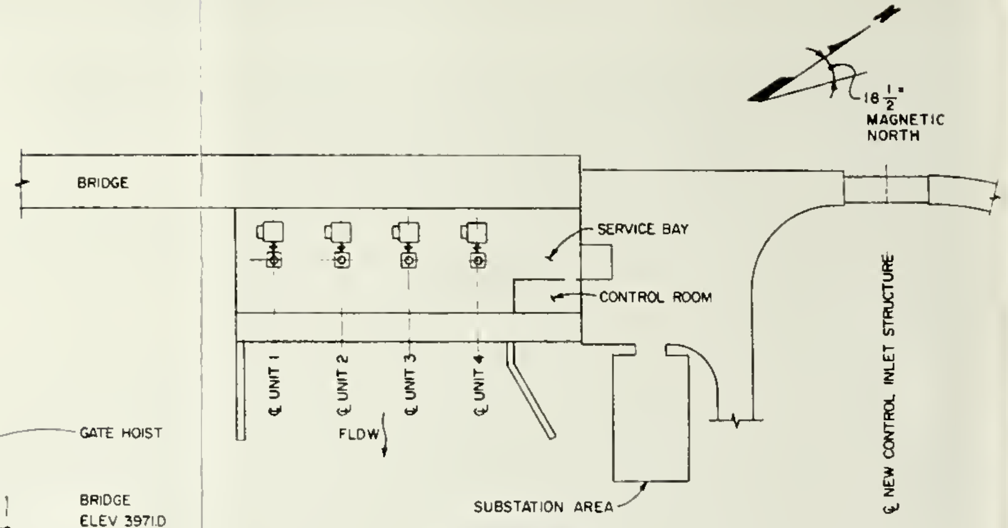
SECTION A

SCALE $\frac{1}{8}$"=1'-0



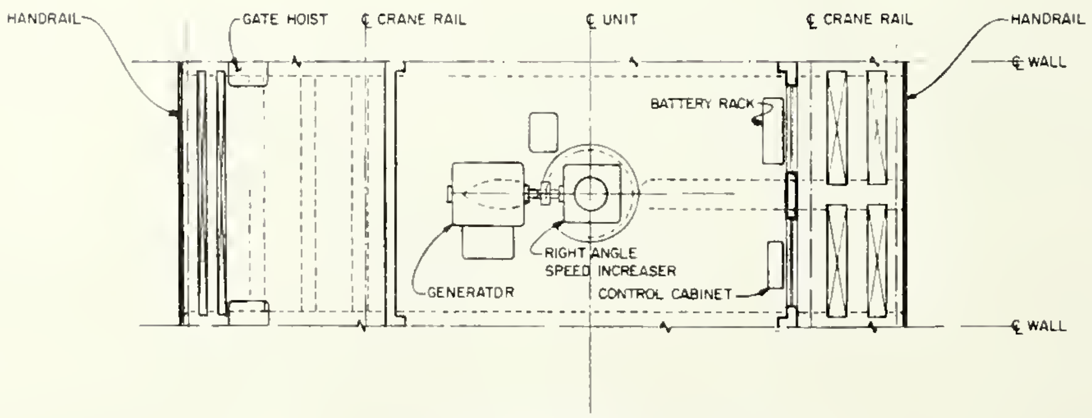
SECTION B

SCALE $\frac{1}{8}$"=1'-0



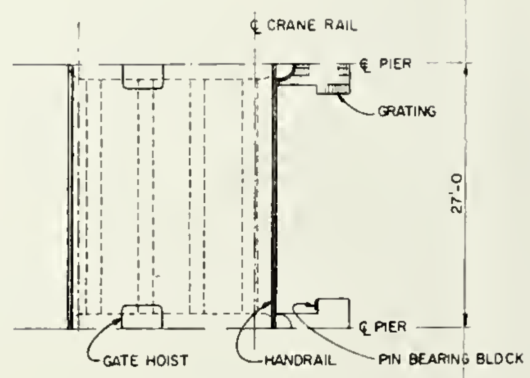
KEY PLAN

NOT TO SCALE



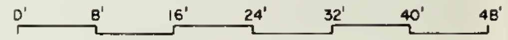
TYPICAL POWERHOUSE LAYOUT - 4 REQ'D

SCALE $\frac{1}{8}$"=1'-0



TYPICAL BRIDGE PLAN

SCALE: $\frac{1}{8}$"=1'-0



SCALE: $\frac{1}{8}$"=1'-0

EXHIBIT F - 2

PROJECT NO. 2853 MONTANA

MONTANA DEPARTMENT OF NATURAL RESOURCES
AND CONSERVATION
HELENA, MONTANA

BROADWATER POWER PROJECT

DESIGN DRAWING

TUDOR ENGINEERING COMPANY SAN FRANCISCO, CALIFORNIA

EXHIBIT G

PROJECT MAP

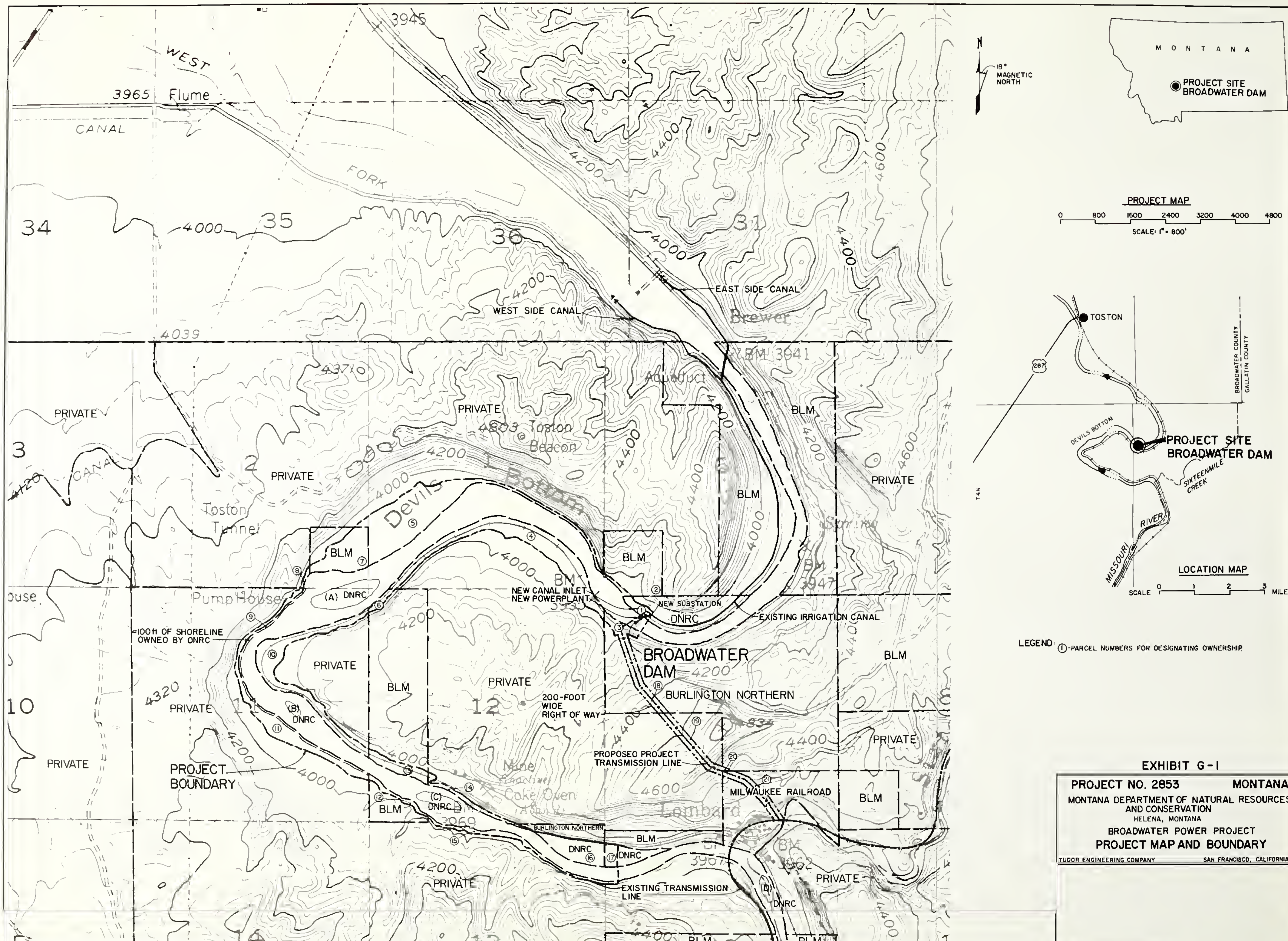


EXHIBIT G-1

PROJECT NO. 2853 MONTANA

MONTANA DEPARTMENT OF NATURAL RESOURCES AND CONSERVATION
HELENA, MONTANA

BROADWATER POWER PROJECT

PROJECT MAP AND BOUNDARY

TUDOR ENGINEERING COMPANY SAN FRANCISCO, CALIFORNIA